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AUGUST 23, 1956
EVERY OTHER THURSDAY

MACHINE DESIGN

A PENTON PUBLICATION

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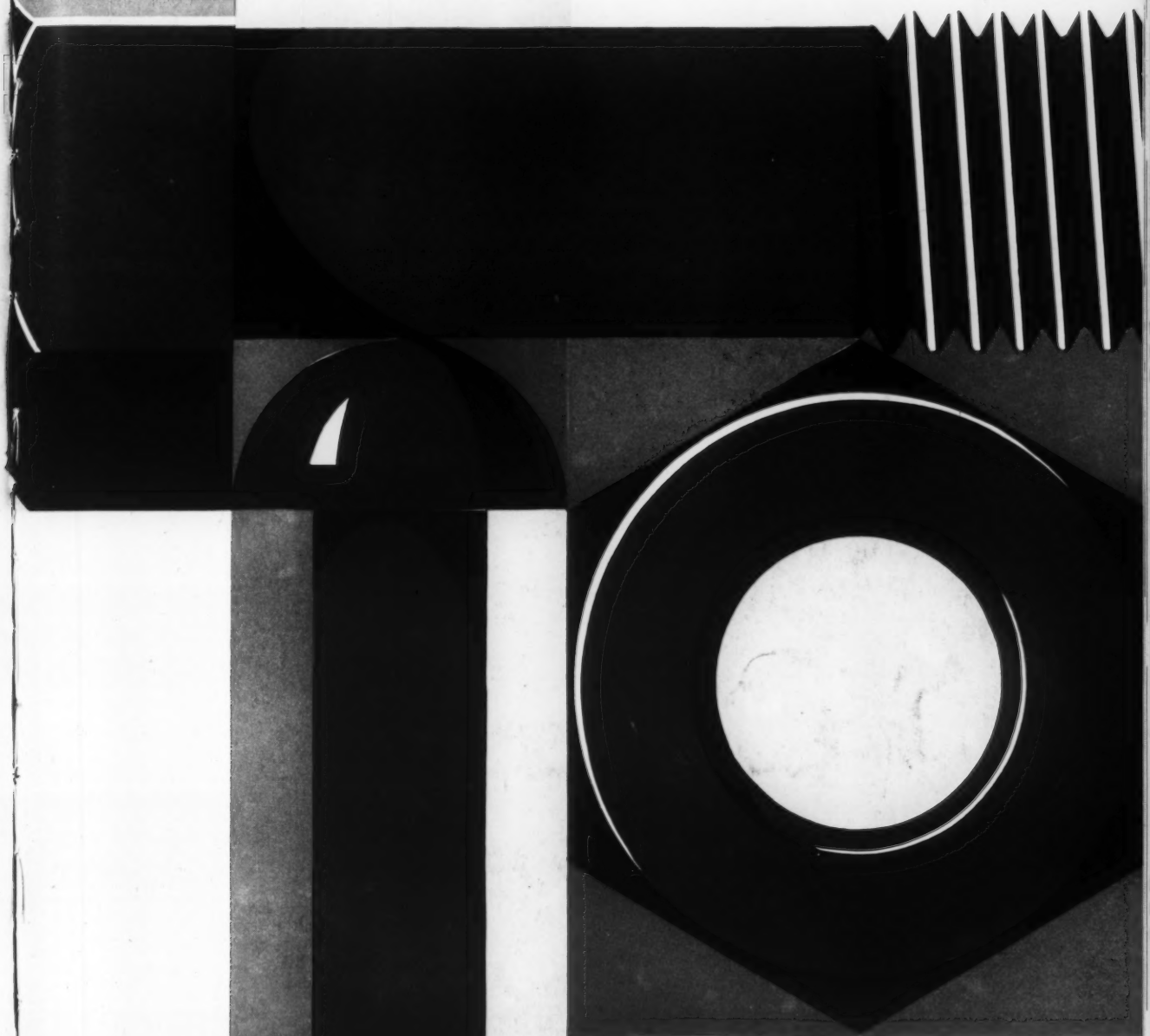

FASTENERS

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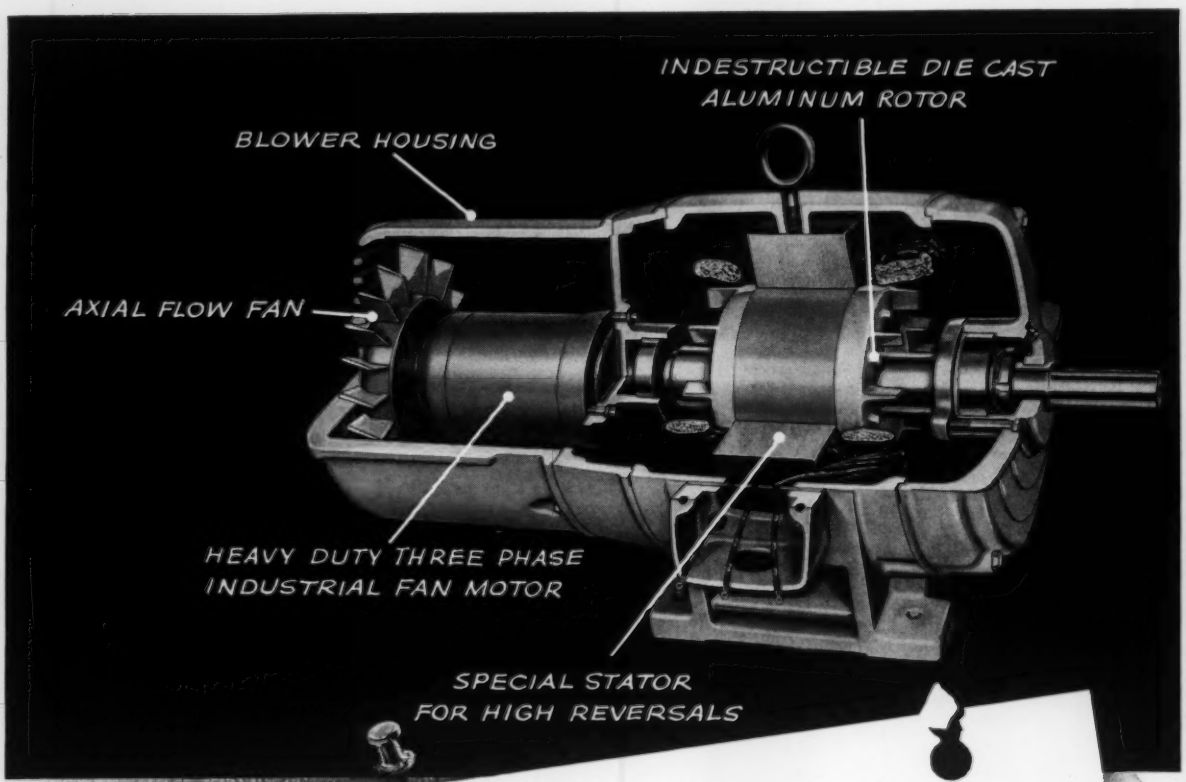

INDESTRUCTIBLE DIE CAST ALUMINUM ROTOR
BLOWER HOUSING
AXIAL FLOW FAN
HEAVY DUTY THREE PHASE INDUSTRIAL FAN MOTOR
SPECIAL STATOR FOR HIGH REVERSALS

212 idle reversals per minute*

Special blower assembly continuously cools Louis Allis rapid-reversing motors, to permit high rate of reversals

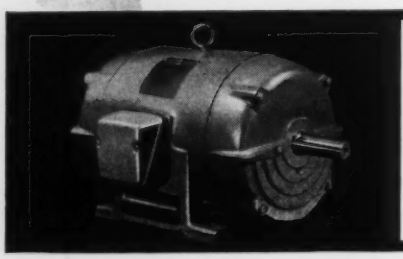
Here's a motor built especially to withstand the tough demands of rapid reversal applications. It is kept cool by its own integrally mounted blower that forces cooling air through the motor and over the windings and end rings.

Other factors that lead to long dependable motor life are: Large stator slots and special slot shapes that allow maximum copper in the windings. Specially annealed and coated lamination steel that reduces losses and increases the number of reversals possible. New Phenolic impregnating varnish that protects the insulation with outstanding thermal and chemical resistance for Class A insulation. Also built with Class B and H insulation.

These reversing motors meet standard NEMA mounting dimensions except for the increased length caused by the addition of the blower. And you can get constant torque or constant horsepower ratings in single and multiple windings for two or more speeds. Sizes range from 1/2 to 15 hp. See your Louis Allis field engineer for complete information about this remarkable new motor development.

Send for bulletin 1800 describing these new motors.

*3 HP, 1200 RPM with Class H Insulation



A complete line of standard rerated motors in frames 182 through 326U now in stock. Special rerated motors are available on short delivery.

THE LOUIS ALLIS CO.
MILWAUKEE 7, WISCONSIN

Circle 501 on page 19

YOU ASKED FOR IT

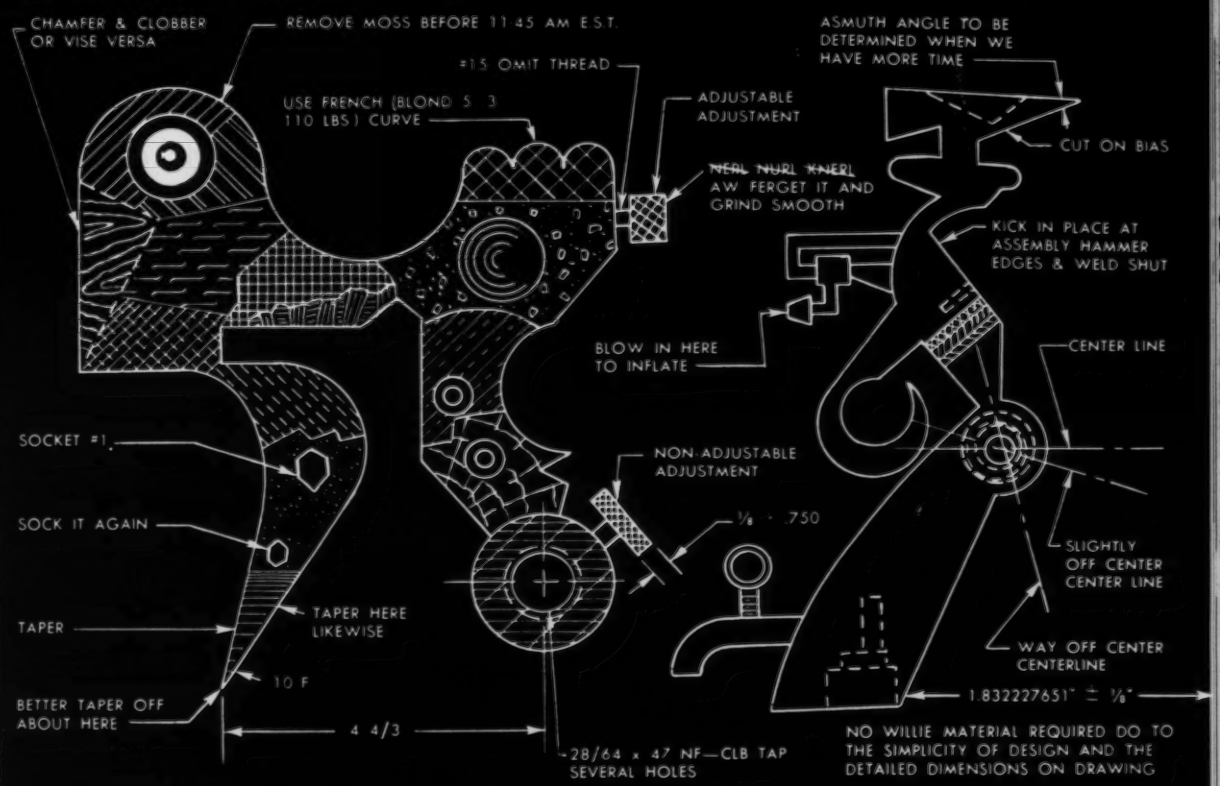
Answering your request is our pleasure. Whether for a special purpose valve or—in this case—the front cover of the ROSS EnginAIR, our bi-monthly technical publication, a re-print of which so many of you have asked for. Additional reprints on request.

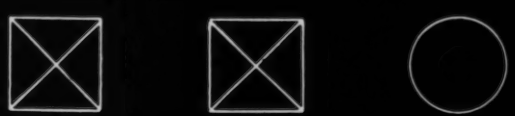
Ross OPERATING VALVE COMPANY
109 E. GOLDEN GATE AVE. • DETROIT 3, MICHIGAN

ROUTE TO:

RETURN TO:

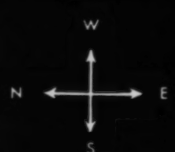
enginair


CHAMFER & CLOBBER OR VISE VERSA
REMOVE MOSS BEFORE 11:45 AM E.S.T.
#15 OMIT THREAD
USE FRENCH (BLOND 5' 3" 110 LBS.) CURVE
ADJUSTABLE ADJUSTMENT
NEAL NURL KNERL A.W. FERGET IT AND GRIND SMOOTH
ASMUTH ANGLE TO BE DETERMINED WHEN WE HAVE MORE TIME
CUT ON BIAS
KICK IN PLACE AT ASSEMBLY HAMMER EDGES & WELD SHUT
BLOW IN HERE TO INFLATE
CENTER LINE
SOCKET #1
SOCK IT AGAIN
NON-ADJUSTABLE ADJUSTMENT
⅛ - .750
SLIGHTLY OFF CENTER CENTER LINE
TAPER
TAPER HERE LIKEWISE
10 F
BETTER TAPER OFF ABOUT HERE
4 4/3
WAY OFF CENTER CENTERLINE
1.832227651" ± ⅛"
28/64 x 47 NF—CLB TAP SEVERAL HOLES
NO WILLIE MATERIAL REQUIRED DO TO THE SIMPLICITY OF DESIGN AND THE DETAILED DIMENSIONS ON DRAWING



BUGS TO BE ELIMINATED AT FINAL ASSEMBLY

CAUTION
KEEP UPPER BOTTOM RIGHT HAND CORNER OVER ABOUT ⅛ LOWER THAN LEFT HAND CENTER CORNER WHICH SHOULD BE DOWN A LITTLE HIGHER THAN MIDWAY APPROXIMATELY

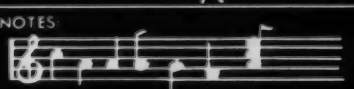


INSTRUCTIONS
A. DIAMETER WAITING APPROVAL OF SOME TWO BIT CLERK IN THE OFFICE OF SHAPE STANDARDIZATION

THIS IS HOW TWO LINES OF PRINTING LOOK WHEN PRINTED UPSIDE DOWN

PREPARED BY: Ross OPERATING VALVE CO.

NOTES



ANY SIMILARITY BETWEEN THE MACHINE AND ANY IDENTICAL MACHINE IS PURELY INCONSEQUENTIAL

SPRING FEVER—DRAFTSMAN'S STYLE

AC LM CM

Circle 504

GOODYEAR INDUSTRIAL PRODUCTS
G.T.M.-Specified
Molded Flange-Wrap Golf Grip
A
Hard, tough cap molded to size
B
Built-in, two-way taper assures perfect taper of grip on club without listing
C
Suede-finished, sun- and sweat-resistant rubber permits firm, comfortable grip

Answer to a gripping problem!

You're a man with an idea.

You want to market a new kind of golf grip. It will be a strip of rubber that simply wraps on the bare club shaft—no adhesive or listing needed. And, because the rubber will be under tension, it will secure the grip, absorb shock, add distance to drives.

You know what you want, but not how to get it. You try several specialty rubber molders, with little success. Finally, because of his wide experience in successfully solving many specific problems with molded rubber, you turn to the G.T.M.—Goodyear Technical Man—for help.

He works closely with you, suggests improvements in designs, develops a special compound with a suede finish. Result: Now, the grip does everything you hoped it would and more—actually improves with age. Your idea is a fact!

Another fact: The G.T.M. can be of material help on any molded rubber problem, whether it involves engine mounts, shock absorbers, seals, diaphragms or a host of other industrial items. Contact him, today, by writing Goodyear, Industrial Products Division, St. Marys, Ohio, or Akron 16, Ohio.

Flange-Wrap—T.M. C.S.I. Sales Company, Solon, Ohio

MOLDED GOODS by

GOODYEAR

THE GREATEST NAME IN RUBBER

Circle 505 on page 19

THE PROFESSIONAL JOURNAL
FOR ENGINEERS AND DESIGNERS

MACHINE DESIGN

August 23, 1956
Volume 28—No. 17

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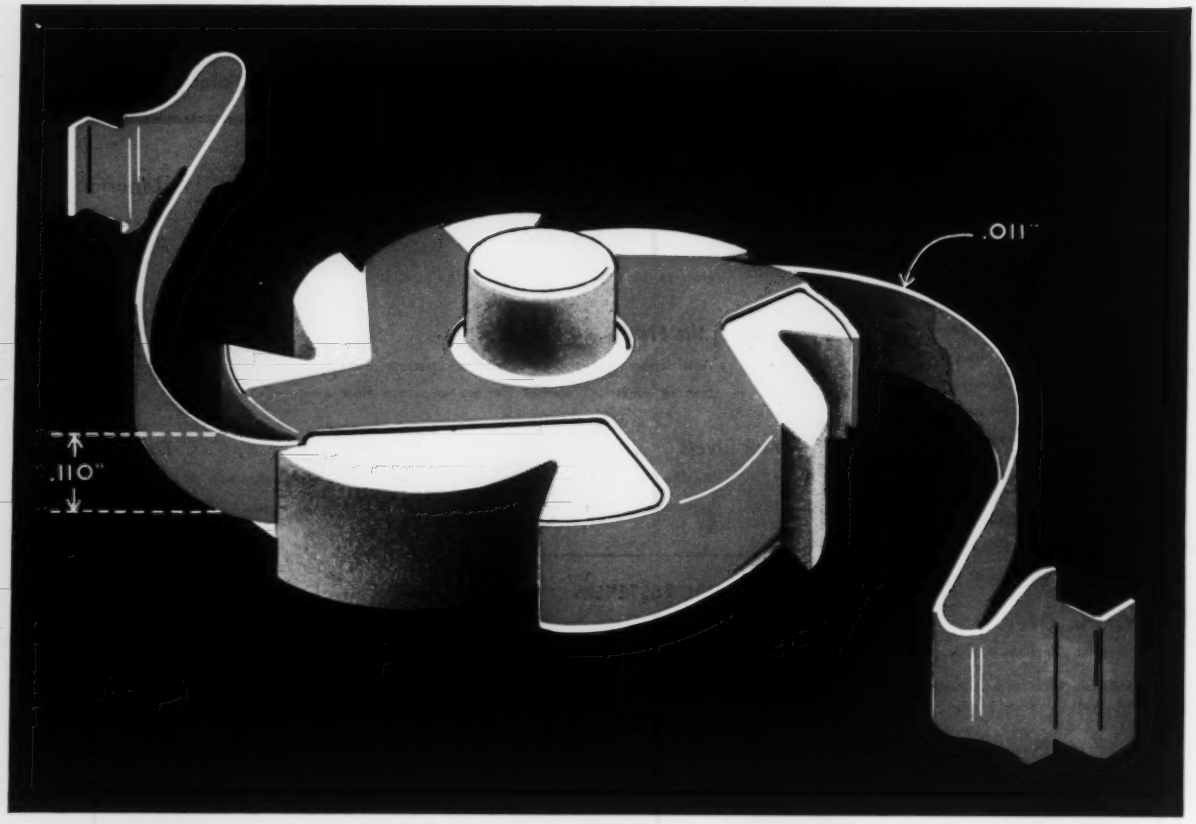
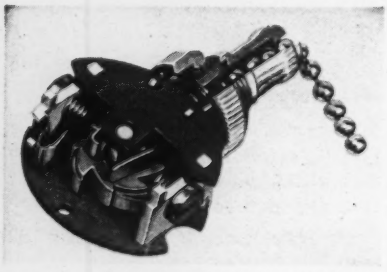


Enlargement showing the contact springs at the "heart" of one model of the Levolier® switch mechanism. Levolier switches are used in industrial and commercial lighting, in heavy-duty industrial sockets, in appliances, fixtures, etc.

The Anaconda alloy tailored for this punishing service actually costs less



Cutaway of Levolier Switch No. 41 shown approximately actual size.

THE PROBLEM: The McGill Manufacturing Company, Inc., Valparaiso, Indiana, was interested in a desirable substitute for a premium copper alloy used in contact springs for their widely known Levolier switch mechanisms. Unexcelled quality had to be maintained with a new alloy that would help hold prices against rising costs. As these switches are designed for long service and heavy-duty industrial service, the spring material has to be tough and durable.

THE SOLUTION: In 1952, McGill discussed the problem of an alternate spring material with a metallurgical engineer from The American Brass Company. After an analysis of the requirements, a special Anaconda alloy was offered—Ambronze-422, rolled to spring temper.

Samples were prepared and tested by McGill and Underwriters' Laboratories. The material performed satisfactorily in standard tests—current carrying capacity, 6 amps at 125 volts d.c.—readily exceeded the requirements of 75,000 cycles, or 150,000 individual operations.

In production, the new Anaconda alloy also performed satisfactorily. It was necessary to make only one minor die-forming change. McGill received a desirable saving in material costs—product quality remained high—and the material was available as needed to maintain production.

FREE TECHNICAL SERVICE: This is another example of the Anaconda technical service available to metal users. Sometimes a new alloy is required—other times a variation of a standard alloy will do the job. The Technical Department of The American Brass Company, through its day-to-day work with a wide variety of metal problems, offers a tremendous breadth of experience, which is at your disposal. See your American Brass Company representative or write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario. 5884

ANACONDA® COPPER AND COPPER ALLOYS

Circle 506 on page 19

Engineering News Roundup

Products of the Future Seen Extending Use of Glass

MINNEAPOLIS, MINN.—The per capita use of plate and window glass in the U. S. has increased by more than 200 per cent in the last 30 years, but the real "glass age" still lies ahead, according to David G. Hill, president of the Pittsburgh Plate Glass Co. In a recent address, Mr. Hill indicated a number of potential applications for glass in the near and distant future.

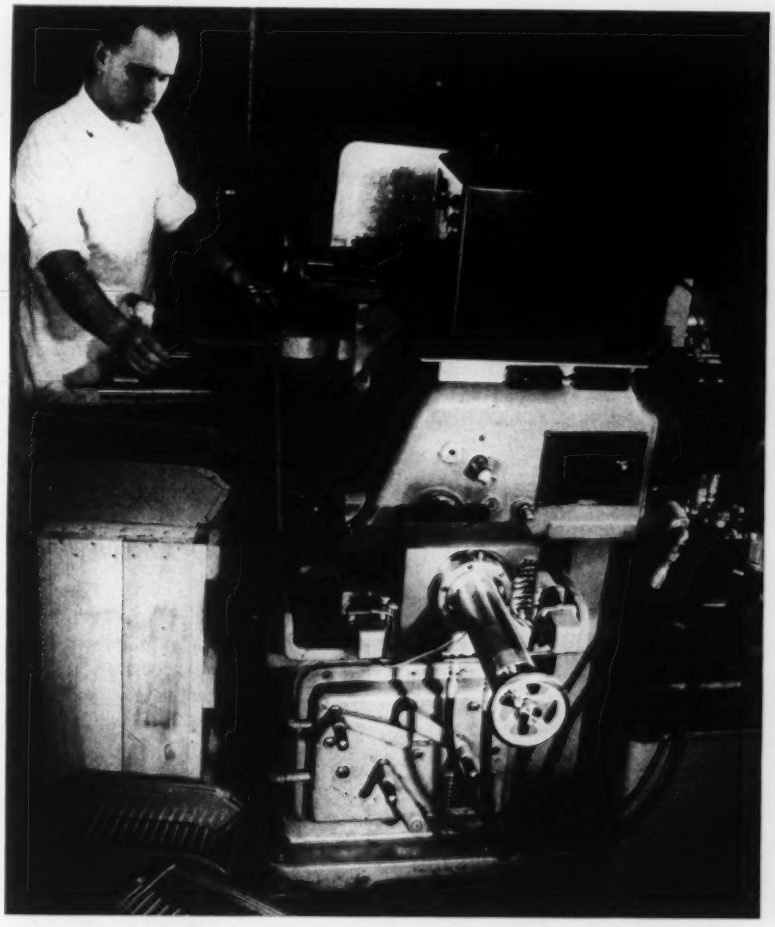
According to Mr. Hill, the most challenging product of tomorrow is the variable transmission window in which opacity to light and radiant heat can be adjusted either manually or automatically.

Electroluminescent panels for lighting interiors are already well along in the laboratories. These panels give off a low intensity of light when an electric field is applied and represent an extension of the mercury light concept.

Mr. Hill reported that glass covered with electrically conductive coats has been used successfully as a source of heat. In the future, he said, electrical energy will become lower in comparative cost and thereby make this method for controlled heating more common.

The conservation of energy is an increasingly important problem. The fossil fuels, such as coal, may be partially replaced in the future as a source of energy by nuclear fuels, but even these have finite limits. Increasingly, the sun is being emphasized as our principal source of available energy.

Glass will be used to allow the entrance of radiant heat into enclosures where it is absorbed and also as a barrier to prevent the escape of heat by convection and conduction once it has been captured. There are already examples of the use of glass for this purpose.



Inchworm motor is a new linear actuator that employs the phenomenon of magnetostrictive effect to operate like a precision leadscrew. It is assembled here in a centerless grinder which is finishing piston pins.

New Motor Works Like High-Precision Leadscrew

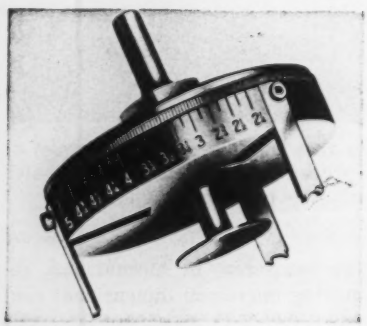
MINEOLA, N. Y.—A new linear actuator, called the Inchworm Motor, has been developed by Airborne Instruments Laboratory Inc. to fill the need for a powerful feed mechanism accurately controllable in the range of microinches. The motor is considered a successor to the leadscrew in mechanisms requiring microinch dimensional control (0.000005 to 0.0001-in.). Its first large-scale application in the machine tool field is in replacing the leadscrews in certain centerless grinders.

The Inchworm literally steps along in microinch steps, expanding and contracting like its familiar namesake. Employing a phys-

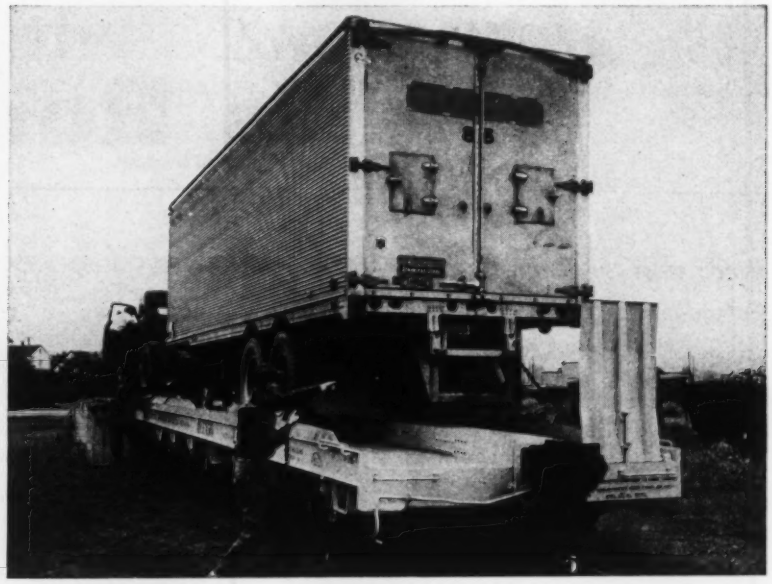
ical phenomenon called the magnetostrictive effect, the armature of the motor shrinks under the influence of an electromagnetic field, snapping back to original size when the magnetic field is de-energized. A pair of clamps operating in conjunction with the armature convert the expansion and contraction undulations into forward or backward motion, reversing on demand without backlash.

In conventional machine tools, the cutters are generally mounted on a heavy member which slides on accurate ways formed as part of the machine bed. The ways possess a phenomenon known as stick-slip. Stick-slip is the characteristic of a larger force being required to start two members sliding with respect to each other than the force required to maintain a slow, steady velocity between the members. This phenomenon must be overcome or reduced before positioning to millionths-of-an-inch can be accomplished.

It is claimed that the Inchworm actuator controls stick-slip to the extent that minimum increment of slide motion has been reduced by a factor of 15. Typical installations have consistently repeated to an accuracy ± 5 millionths of an inch under machine load conditions requiring a break-loose force of 300 lb and a sliding force of about 220 lb.



ADJUSTABLE BLADES of the Erwood Dial Saw hole cutter permit cutting holes 2¼ to 5 in. in diameter. Setting the cutter for the desired size hole is accomplished by means of a dial. Two types of blades are supplied to cut steel, brass, plastic or wood.



LOW OVERHEAD is the feature of this new railroad flat car developed for piggy-back service by American Car and Foundry Div. of ACF Industries. Called "Lodapto", the 38-ft car is 10 in. lower than a conventional car, has 4 wheels, fixed axles, roller bearings, rubber draft gear, standard couplers.

Plane Parts Made Accurately By Compression Forming

BURBANK, CALIF. — At Lockheed Aircraft Corp., manufacturing research engineers have recently introduced a high-precision method of shaping sheet-metal parts to very small tolerances. The method is called compression forming. With it, Lockheed is turning out sheet-metal parts with tolerances as low as 0.010-in. Compression forming represents a new use of the standard rubber hydropress.

Initially, an aluminum sheet-metal part is formed to broad tolerances by a rubber hydropress at approximately 100 psi. Upon being taken from the press, joggles are defined and any waves in the flanges are removed by hand. The part is then shaper-sawed to establish a uniform flange width. The part, now preformed, is heat treated at 925 F for 30 minutes and quenched in cold water.

While in a malleable condition, the part is inserted in the compression die for sizing. First, a plunger built into the die transmits pressure at 1000 psi down through a rubber pad to the main body of the preformed part. This pressure causes the metal to spread out and fit itself to the over-all contours of the die.

A fraction of a second later, a second compressing action is exerted on the outer edges of the part. As a result of this "two-way squeeze," the part now is contoured to the precise shape of the die. When the forming force is removed, the part elastically recovers a predictable amount, thereby producing the desired part exactly to specifications.

After final forming, the part is artificially aged to the hardest

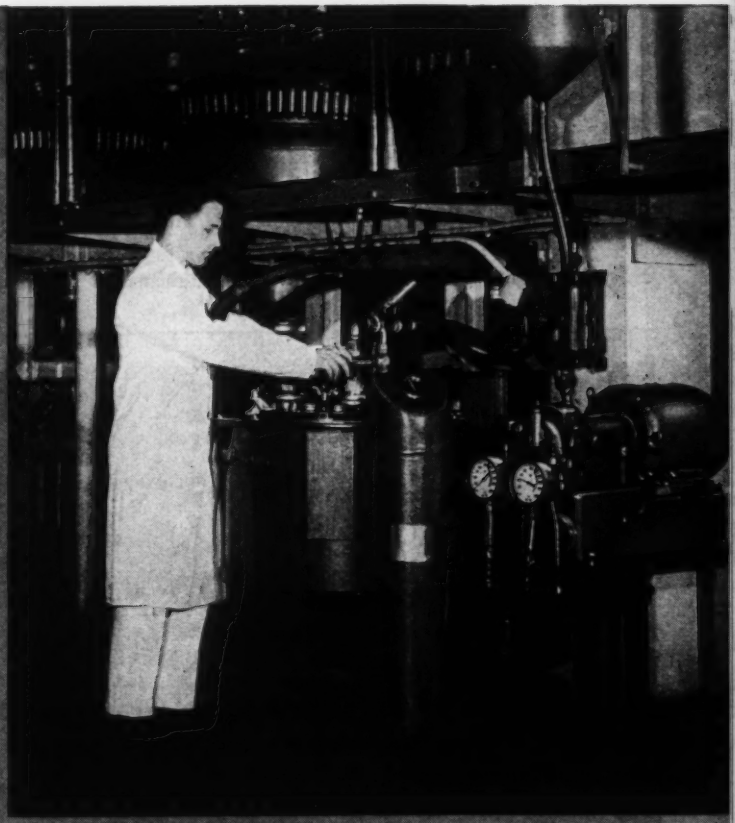
Front Cover

Over 190 different types of industrial fasteners are described in "Design Guide to Industrial Fasteners," Page 105, this issue. One of our mathematically inclined editors has figured out that this issue's front cover could devote ½ sq in. to each, if all were displayed. Rather than take on the formidable task of drawing each and every fastener to miniature scale, artist George Farnsworth has shown three of the most common— a nut, bolt and rivet.

Any speed for you too!

Unique Oilgear Fluid Power "ANY-SPEED" Drives establish new production and economy records

Any desired speed from zero to maximum . . . any rate of acceleration . . . any rate of deceleration . . . any rate of hydrodynamic braking . . . any speed adjustment between operations . . . synchronization of two or more drives . . . direct or remote precision speed control irrespective of load, input power or oil viscosity changes . . . all with Oilgear Fluid Power "Any-Speed" Drives. Old and new users name them *"the drives"* for their heavy-duty needs. You probably didn't know this! Every day, people are equally surprised—*and far more amazed when they know the facts.* Write and get them *now*. THE OILGEAR COMPANY, 1568 W. Pierce Street, Milwaukee 4, Wisconsin.

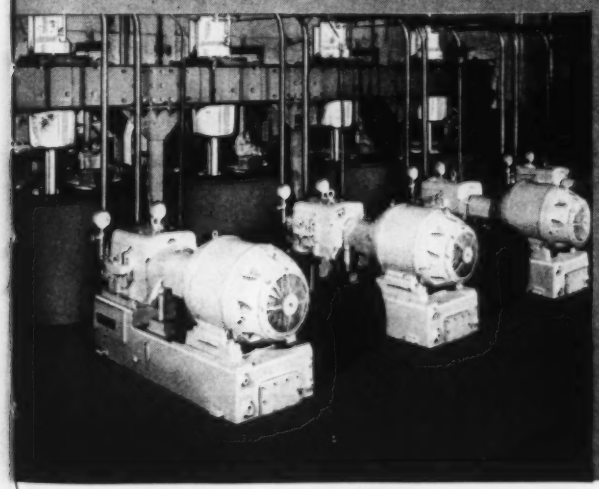


This Centrifuge at Abbott Laboratories

Leading house in pharmaceutical, drug and chemical field, Abbott Laboratories installed first Oilgear Drive on Tolhurst centrifuge in production department. Experience was so satisfactory it led to the inclusion of another Oilgear equipped Tolhurst centrifuge in their experimental laboratories.

SPECIFICATIONS: Speed continuously variable from zero to 1200 rpm max. (in this case). Full control of acceleration/deceleration speed and rate. Permits that infinitely modifiable speed best suited to loading, washing, spinning and unloading.

Photo Courtesy, Chemical Processing Magazine



This Centrifuge at powder plant in east

In a somewhat different application, these 4 Oilgear 60 hp "Any-Speed" Drives serve Tolhurst centrifuges in powder plant in the east. Centrifuge accelerates to 300 rpm for loading, to 900 rpm for 15-minute centrifuging, then decelerates to 70 rpm for "plowing." Unloading is automatic.

OILGEAR
Fluid Power

PIONEERS . . . NOW THREE PLANTS FOR FLUID POWER

Tolhurst is a division of American Machine & Metals, Inc.

Circle 507 on page 19

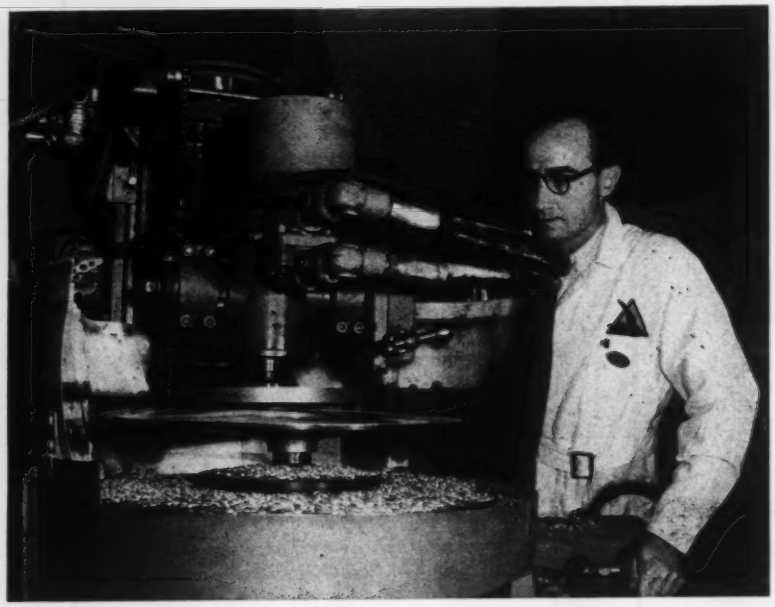
PUMPS, MOTORS, TRANSMISSIONS, CYLINDERS AND VALVES

condition that aluminum can acquire—72,000 psi—by heat treating it at 250 F for 24 hours. In this final condition the aluminum part is claimed to be stronger than structural steel of equal thickness. Also, the compression-formed part is claimed to be as accurate as the same part would be if machined from a casting or forging.

A key factor in the application of the new technique to sheet-metal parts is the reduction and control of springback. The compression forming method squeezes every grain of the metal to the point where all fibers are neutralized and the metal enters its plastic range.

Based on experimental tests, Lockheed engineers claim it is now known that sheet metal's natural tendency to recover elastically can be accurately controlled and predicted through the use of compression forming.

Making allowance for this predictable springback and for expansion of the metal, a die of epoxy plastic is made undersize—0.003 in. per in. narrower than the outside dimensions of the part.



"REFRACTOFORM" GRINDER, developed in the Northrop Pasadena Optical Laboratory, forms parts of astronomical instruments in 7 minutes that formerly took 33 man-hours. Hydraulically activated, it can grind glass or metal components in any shape—flat, spherical, aspherical, or any surface of revolution. Products are finished by hand and held within a tolerance of 1.1 millionths of an inch in 10 inches. Here the grinder shapes a backing plate used for polishing a concave mirror.

Machine Prints Numerical Record Of Continuous Gaging

WEST HARTFORD, CONN.—A printed card record of on-gage and off-gage footage of rolled strip metal turned out by a rolling mill is prepared by a production analyzing totalizer recently developed by the Gage division of the Pratt & Whitney Co. Inc.

The unit operates in combination with either contacting or non-contacting continuous strip thickness gages. It prints a permanent record in numerical, rather than chart, form.

A typical installation on a finishing mill will accumulate the un-

Topics

Gamma gas could be a name for the gasoline produced recently with the aid of gamma radiation. The fuel was made "on a purely experimental small-scale basis" by Esso Research.

• • •

First research reactor in free Europe for training engineering students in nuclear science will be installed at Munich's Technische Hochschule. The reactor will be built by AMF Atomics Inc.

• • •

An air-drying solid film lubricant, usable in the temperature range from —300 to 500 F, has been developed by Electrofilm Inc. The resin-base lubricant is packaged in a spray-on, aerosol container. It dries in 30 minutes and can be used with or without oils and greases.

• • •

Printing 10,000 letters or figures a second in the face of an electronic tube is accomplished by the Charactron, a device produced by Stromberg-Carlson. Applications are in high-speed computing machines and in recording radar contacts of ships or aircraft with ground stations.

• • •

The *Nautilus* has cruised 50,000 miles without refueling. The sub first put to sea under nuclear power in January of 1955.

• • •

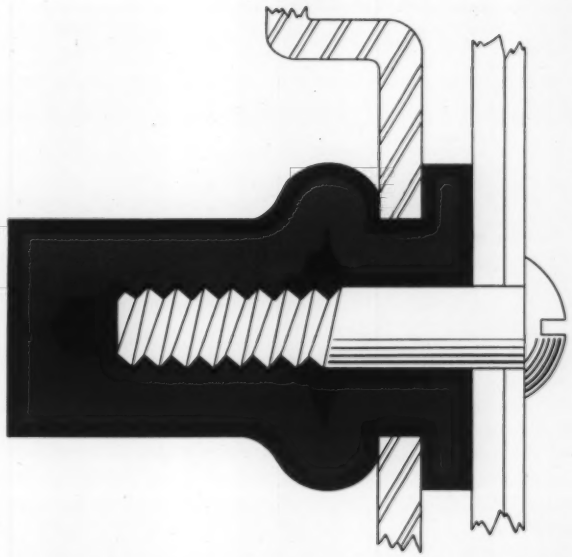
Frozen runways in Georgia are hard to come by, so Lockheed experimental engineers there are virtually bringing the runway to the plane in their development of aircraft for Arctic operation. To simulate the effect on a plane's underbelly of landing on rough, icy fields, fuselage sections overlaid with various test materials are bombarded with 40-lb blocks of ice. The ice, suspended from a car that speeds over the section under test, strikes the material at the same angle a plane would hit ice mounds when landing.

• • •

Electronics in the bank provide a completely automatic bookkeeping system. The Teleregister Corp. system designed for use in savings banks uses electronic memory drums instead of ledger cards. Special keysets connected by telegraph lines to the drums provide tellers with instant access to information on depositors' accounts.

B.F.Goodrich RIVNUTS

save time by providing 6-thread nutplate that stays put

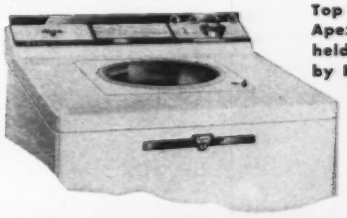


Here's a common fastening problem you can't solve with "nuts and bolts":

You have to fasten a porcelainized, sheet metal top to a frame assembly. Two bolts would hold it but the top must be removable. You can't use nuts; they would drop down inside. Self-tapping screws might tear loose. Cost of installing welded nutplates is prohibitive.

B. F. Goodrich Rivnuts solved the problem for Apex. Upset from *one* side by *one* worker in seconds, Rivnuts provide a nutplate—solid as a rivet—with six clean threads for screw attachment. No matter how many times the top is removed, Rivnuts stay firmly in place with threads intact.

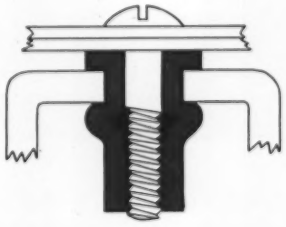
Time is saved two ways: in factory assemblies and maintenance later on. B. F. Goodrich Rivnuts have similarly speeded up thousands of assembly operations, helped provide better products. They can do the same for you. Get more information by writing for Rivnut demonstrator shown below. *B. F. Goodrich Aviation Products, a division of the B. F. Goodrich Company, Akron, Ohio.*



Top assembly of new Apex Wash-A-Matic is held securely in place by Rivnuts installed in the frame.

COMPARE RIVNUTS WITH THESE FASTENING METHODS

RIVNUT

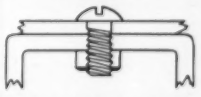


Installed from one side. Gives the strength of 6 clean threads. Provides firm, accurate nutplate. Serves as spacer head. Installed in seconds, *after* enameling.

SELF-TAPPING

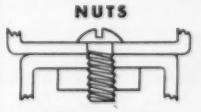
No structural strength
Tears loose easily. Lacks quality
Limits refastening

WELDING



Requires tapping, cleaning, etc.
Must be done before enameling
Gives fewer threads. Costs too much

NUTS



Can't be installed blind
Drop down inside during removal
Difficult to install

RIVNUT

THE ONLY ONE-PIECE BLIND RIVET WITH THREADS

SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Demonstrates with motion how you can use Rivnuts to fasten WITH and TO. Explains construction, simplicity of installation. Get your free copy by writing to: *The B. F. Goodrich Co., Department MD-8B, Akron, Ohio.*

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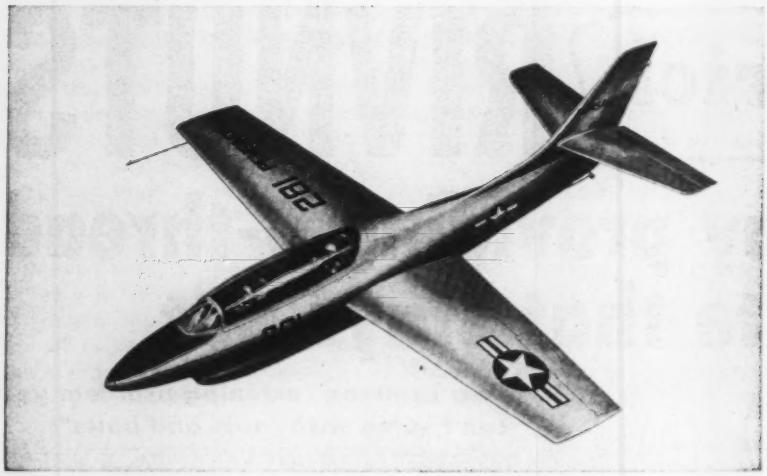


FAST NEW TRAINER, designated T2J, will be built for the Navy by Columbus Div. of North American Aviation Inc. The trainer, jet-powered, will have a top speed of more than 400 knots and a service ceiling above 40,000 ft. The new plane will be capable of operation from carriers and its design will emphasize safety, ease of maintenance, reliability and economy.

dersize, on-gage, oversize, and total footages in a coil on the last pass through the strip mill. At the end of the pass the operator inserts the standard production work card in the printer, and these footages as well as the time, the date, the coil number, the operator's number, and sets of tolerance zones, are imprinted for the permanent record. During this operation the counters are automatically reset for the next coil. Tolerance limits can be adjusted to meet requirements.

Contents of Pipelines Now Measured Continuously

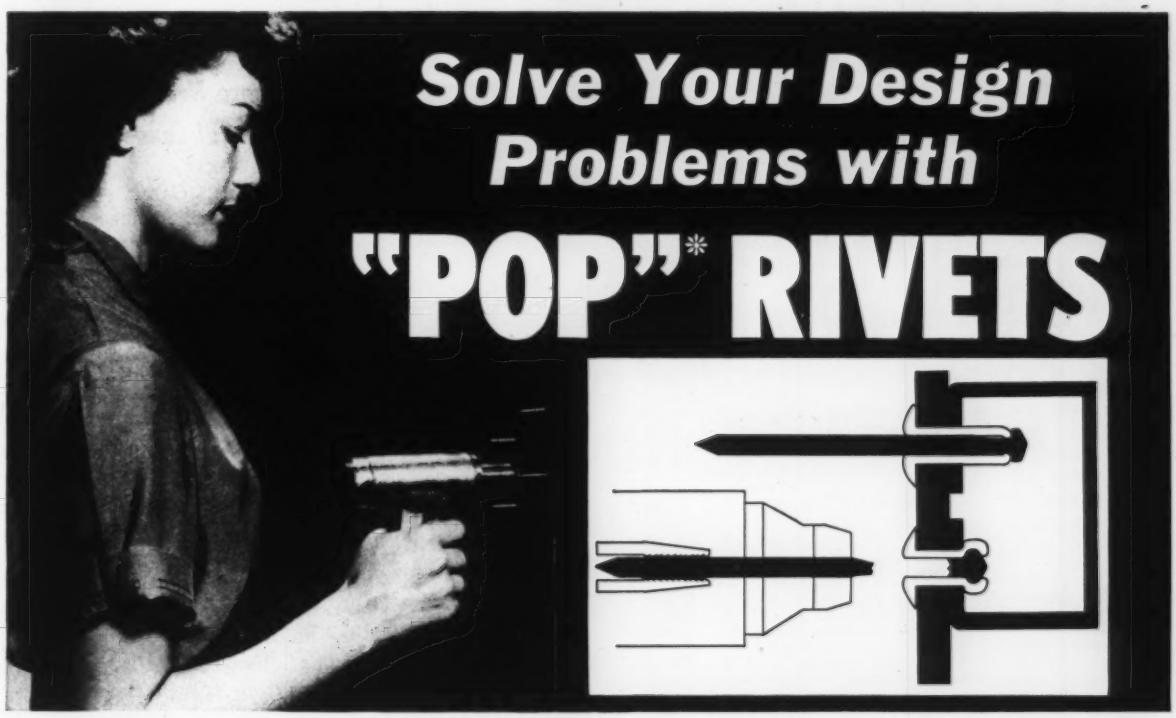
WEST ENGLEWOOD, N. J.—A new instrument developed by Industrial Gauges indicates the kind of gas, fluid or material flowing in a pipeline without drawing off a sample. Called Indexometer, the instrument measures the index of refraction of the pipeline contents. Readings can be made at the pipeline or several miles away.

The Indexometer requires a 1-in. square contact surface with the fluid it measures and does not interfere with the flow or process. The material can be opaque, clear, translucent, reflective or nonreflective. Hermetically sealed, the unit operates at pressures to 1500 psi. Currently, one installation measures sugar content of water in a syrup plant.

Guides for Tommorow will be the theme of the Fifth Annual Meeting of the Standards Engineers Society to be held at the Willard Hotel, Washington, D. C., on October 3, 4 and 5, 1956. Subjects of certain papers to be pre-

Official U. S. Navy Photograph

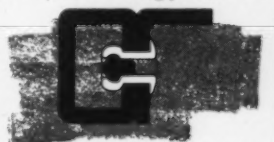
FIRST OF CLASS TO ACCOMMODATE HELICOPTERS, the U.S.S. *Tulare* is the Navy's newest attack cargo vessel. Besides the rear platform for helicopters, the *Tulare* features two four-legged masts that support booms capable of lifting 60-ton landing craft from the sea. The *Tulare* displaces 15,000 tons.



Solve Your Design Problems with "POP"* RIVETS

12 ways "POP" Rivets save money, increase design flexibility, and do a superior job.

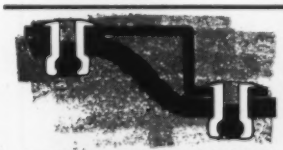
1. LOWER INSTALLED COST. "POP" Rivets can probably save you money even if your present fasteners are FREE.



2. SIMPLE TO USE. Installed by one operator from one side "POP" Rivets are so easy to use that a worker can set up to 1200 hourly.

3. HIGH GRIP STRENGTH. Exert as high as 600 pounds gripping pressure between parts.

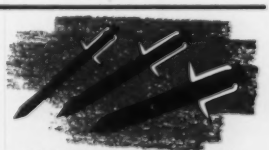
4. LOW HEAD PROFILE. Where space is important, "POP" Rivets' minimum head height is the answer.



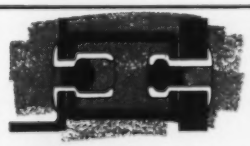
5. NON CRITICAL HOLE DIAMETER. Designer wants holes small, production wants holes larger. "POP" Rivets make both happy.

6. VIBRATION PROOF. "POP" Rivets cannot back out or become loose. No lock washers or nuts required.

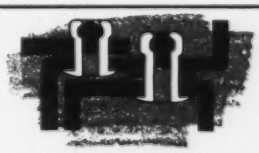
7. PLASTIC TO METAL. "POP" Rivets do not fracture the plastic because it is held in compression.



8. VARIETY OF MATERIALS. Made in aluminum, steel and Monel, in wide range of sizes.



9. THROUGH THICK AND THIN. "POP" Rivets hold tight in thin materials. No threads to strip. Fasten thin sheets or thick and thin with equal ease.



10. GREATER DESIGN FLEXIBILITY. Product design can be made more economical often eliminating separate pieces.

11. CUTS HANDLING COSTS. Bring the rivet to the work — not the work to the fastener.

12. ASSEMBLY LINE FASTENING. "POP" Rivets can be installed at any point. Lightweight, high production tools set rivet. No need for heavy equipment.

"POP" Rivets can provide substantial savings in production time and *installed* fastening costs. Even an unskilled operator can install as many as 1200 "POP" Rivets an hour.

Design limitations caused by fastening requirements are virtually eliminated. Greater design flexibility is provided. Write, wire or phone now for information on how "POP" Rivets can help you solve design problems, cut production costs.

*Trade Mark

"POP" RIVET DIVISION

UNITED SHOE MACHINERY CORPORATION

West Medway, Massachusetts • KEystone 3-6611

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sented are: decimal dimensions, standards for a median company, metals standardization, ABC unification, drawing practice standardization and screw thread standardization. In connection with the meeting, a contest will be held for the best technical paper dealing with some aspect of standardization.

New Foam Laminate Can Form Complex Contours

NEW YORK, N. Y.—A new plastic construction panel consisting of rubber-modified styrene laminated

to a foamed styrene core has been introduced by Chicago Molded Products Corp. The sandwich material can be formed by mechanical means to make parts having bends, corners and complex curves.

The new laminate is said to have high rigidity and strength, light weight and excellent insulating qualities. Typical applications include liners for domestic refrigerator bodies where it is used for its impact-resistant surface which is also attractive and easy to clean.

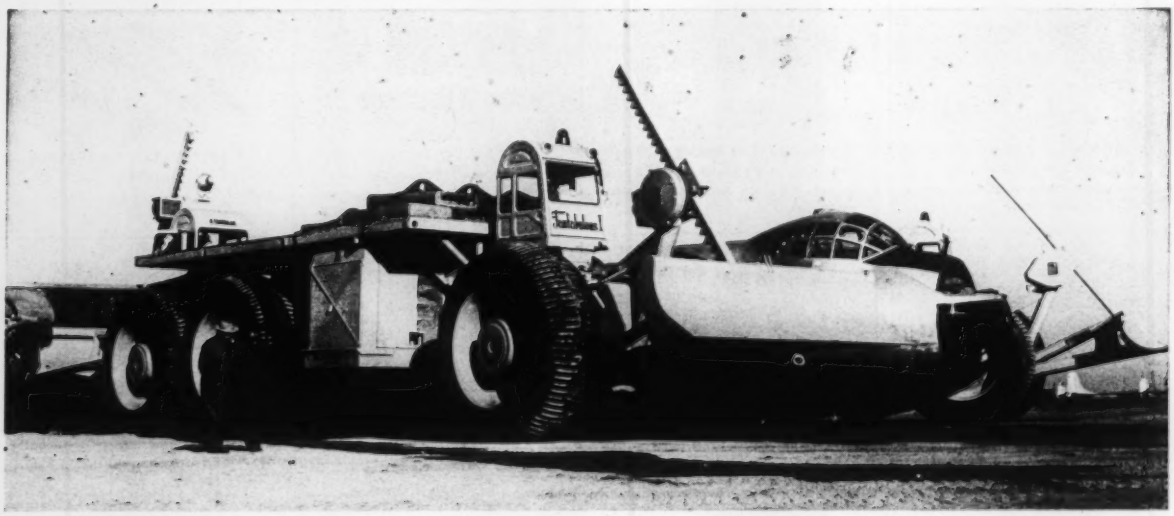
A RAY OF SUNSHINE is converted into electrical power by the Sun Power Pak, right, to operate a new Admiral radio, claimed to be the world's first sun-powered, tubeless portable. Satisfactory operation is possible even on overcast days. The radio also can operate on six flashlight batteries.

Performance Needs Seen for New Electrical Connectors

LOS ANGELES, CALIF. — Environmental electrical connectors that will operate in the range 500 to 600 F and with negligible change of characteristics at altitudes of 80,000 to 100,000 ft must be developed in the next 3 to 5 years. This was one observation of a recent connector symposium at The Deutsch Co. attended by representatives of ten companies and a Naval Ordnance Test Station. The meeting was concerned with five general types: environmental connectors, high-temperature connectors, tapered terminations, terminal strips and miniature quick-disconnects.

The discussion also revealed that potting is still the best-liked method for sealing the back end of a connector and that a universal connector is desired to replace "A," "B," "C" and "E" connectors.

It was agreed that progress in high-temperature connectors is being held up primarily for the development of suitable resilient materials for inserts and potting com-



COLOSSAL CLEANERS designed for emergencies, two LeTourneau Crash Pushers work together in removing crashed aircraft from busy runways. Two of them can remove a 200-ton bomber in less than 20 minutes, a task requiring 5 to 15 hours with previous equipment. Dimensions of each machine exceed 67 by 13 by 17 ft high; weight is 151,000 lb. A two-headed giant, the machine has a blade and an operator's cab at either end. Forward, right and left movements are controlled through electrical switches. Each wheel is driven by an individual electric motor. The pushers have been labeled "Fantabulous" by Air Force personnel.

ALLMETAL Screw Products Company, Inc. • Garden City, L. I., New York
West Coast Div: 2978 Wilshire Blvd. • Los Angeles 5, Calif.

'AN' • Balls • Bolts • Cap Screws • Cotter Pins • Dowel Pins • Drive Screws • Escutcheon Pins • 'MS' • Machine Screws • Nails • Nuts • Rivets • Self-Tapping Screws • Studs • Taper Pins • Threaded Rods • Thumb Screws Tinners' Rivets • Washers • Wood Screws • Woodruff Keys

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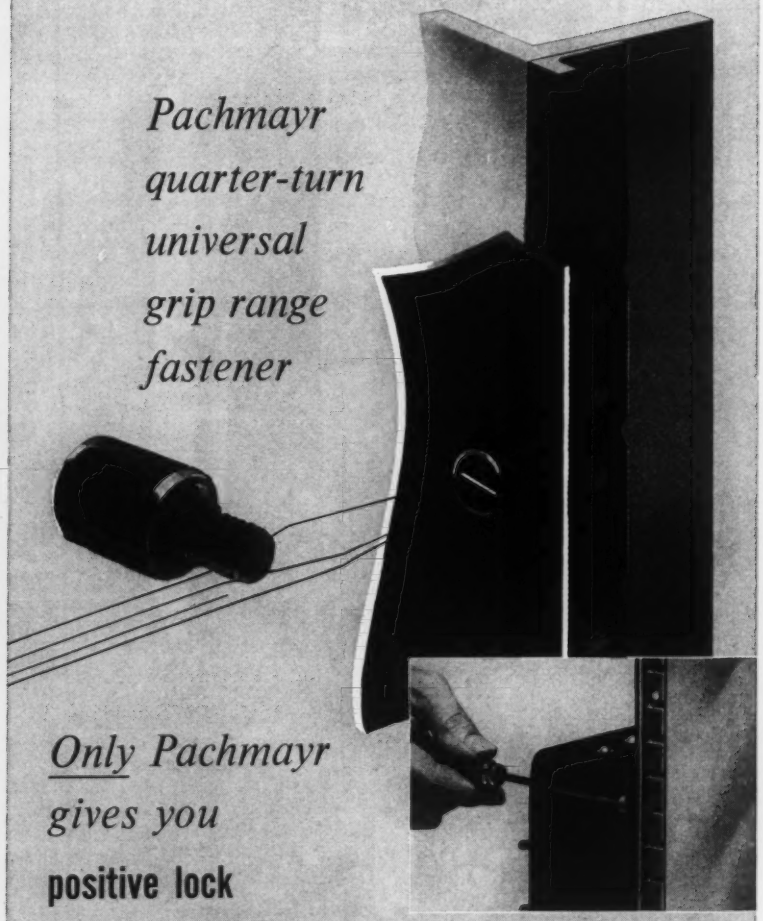
Pachmayr quarter-turn universal grip range fastener



Only Pachmayr gives you

positive lock

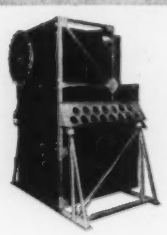
greater grip tolerance

higher strength

- meets MIL-F-8490 . . .
- positive mechanical lock (not a spring) . . .
- higher strength universal grip range, essentially a nut-bolt combination . . .
- offers more cost-saving, superior-performance advantages

CHURCHILL LIGHTING CORPORATION specifies Pachmayr Universal Fasteners for their instrument cases and rack structures, like the one illustrated below. Pachmayr also serves other leading manufacturers.

WRITE FOR DATA. Find out how easily Pachmayr Fasteners solve *any* panel and structure problem. Write today for complete specs *and samples*.



Pachmayr CORPORATION

fastener division

2222 SOUTH FIGUEROA STREET • LOS ANGELES 15, CALIFORNIA

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pounds.

The participants observed recent increase of interest in tapered terminations which could lead to general acceptance of that type.

Most of the participants stated they were going more and more into miniaturization and that they expected the field to grow rapidly, particularly in miniature environmental connectors.

NONINSULATING LINING in this disk-type aircraft brake operates at temperatures up to 70 per cent higher than similar brakes. Instead of individual linings, the Goodyear Tri-Metallic brake has layers of metallic friction mix sintered to both sides of the rotating disks. Low fluid displacement achieved with this design eliminates the need for an adjustment mechanism. The brake assembly requires 200 fewer parts than others of comparable size and capacity.

Small, Light DC Unit Is Accurate Time Standard

LANSING, MICH. — A new device which provides a time base with millisecond accuracy for use in dc voltage applications has been developed by Abrams Instrument Corp. Called "Chronopulse," the unit is basically a pulse generator. Its features are miniature size and the capability to withstand extreme environmental conditions.

Currently, the Chronopulse units

are used in rocket and missile fire controls. In general, they can be modular components in event, program and sequence timing systems.

FIRE PLUG in the form of a tiny electrical alarm plugs into an ac outlet and emits a shrill alarm when overheated. The alarm is touched off by a thermostat when heat reaches 140 F and continues until the temperature drops to 100 F. Current is used only when the alarm is operating. Testing the alarm can be done by holding a lighted cigarette or match to the thermostat button. Called Fire-Spy, the device is made by Laramie Chemical Corp.

High-Pressure Windows Are Glass Sealed to Metal

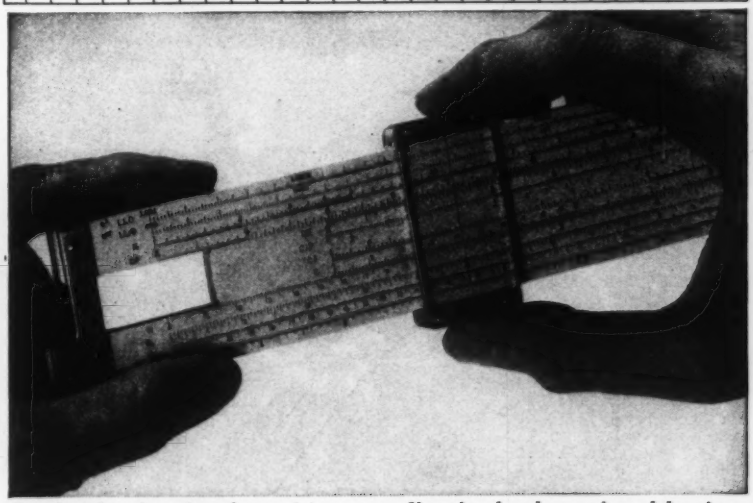
CORNING, N. Y. — Sight glasses which require neither solder nor gaskets, thus eliminating the main sight glass failure points, are now being made by Corning Glass Works. A new manufacturing process makes possible a long-wearing unit in which the glass is hermetically sealed directly to metal.

The new windows are claimed to be tamper-proof, unaffected by aging or vibration, and resistant to high pressures. The windows can be mounted in almost all ferrous and nonferrous metals including brass and stainless steel.

Windows made with the direct seal process have been as small as 3/16-in. diam and larger than 3 in. diam. Window thicknesses have varied from 1/16-in. to ¼-in.

(*Continued on Page 22*)

DRAFTING TRENDS



Developed and perfected just 4 years ago, Versalog has been adopted by virtually all of the leading engineering colleges.

New engineering rule reduces error hazards, requires fewer settings

A highly versatile rule called "Versalog" is perhaps the most significant slide rule development of the past 25 years. Developed by prominent engineers and educators, it is specifically designed for engineering use. With 23 versatile scales, it is universally applicable to all basic engineering fields.

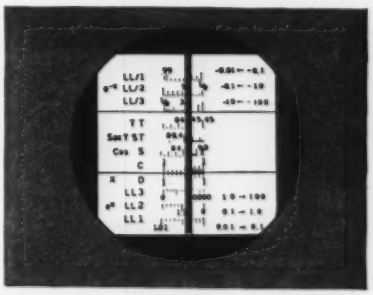
The Versalog offers many new developments, but these four stand out:

The R1 and R2 scales determine square roots with far greater accuracy; *actually four times the accuracy* of conventional A and B scales on other rules.

Exclusive color coding simplifies calculations. The color of the trigonometric scales is simply matched with the same color of the corresponding C, D or C1 scale.

New end zone designations of the log and log log scales permit more accurate calculations. Designations of these scales are inscribed to the left, while the markings to the right designate the value of e covered by each scale.

The LL scales are extended and better arranged. The addition of a fourth scale has increased the range to cover 1.001 to 22,000. The log log scales cover a range from 0.00005 to 0.999.



New end zone designations of the log and log log scales aid the operator in fast, accurate calculations.

Because of its versatility, accuracy and ease of operation, Versalog has been adopted by scores of universities. Seldom has a new engineering product met universal acceptance so quickly.

Like all Post slide rules, Versalog is made from seasoned, laminated bamboo to assure a lifetime of smooth and accurate operation.

Further information on Versalog is available from the Reader Service Division of the Frederick Post Company, 3652 N. Avondale Avenue, Chicago 18.

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ENGINEERING EQUIPMENT & DRAFTING SUPPLIES • FIELD EQUIPMENT & DRAFTING FURNITURE

Circle 512 on page 19

GEARS *that keep* AMERICA *on the* GO!

In vehicles of almost every description—from boats to heavy farm machinery—you'll find flywheel ring gears, transmission gears, differential drive gears, and other gears that are designed, engineered, and manufactured by Automotive Gear Works.

If your product uses gears for power transmission, it may pay you to look into the popularity of gears manufactured by Automotive Gear Works—and learn how we serve as the "gear department" for so many leading manufacturers. Why not write today for further information?

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Reader Information Service

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USE A YELLOW CARD
for More Information . . .

CIRCLE ITEM NUMBERS—Throughout the magazine, each advertisement carries an Item Number for use in requesting further information. All product descriptions, announcements and Helpful Literature items are also numbered, and for greater convenience are indexed below by Item Numbers.

EDITORIAL CLIPSHEETS—So you won't have to "clip" this issue, we'll be glad to send a personal copy of any article as long as the supply lasts. Just fill in the page number and title of article in the place provided on the Yellow Card.

Index to New Parts & Helpful Literature

BY ITEM NUMBERS

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402	427	452	477	502	527	552	577	602	627	652	677	702	727	752
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Penton Building
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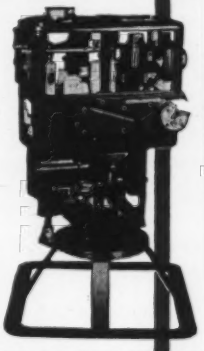
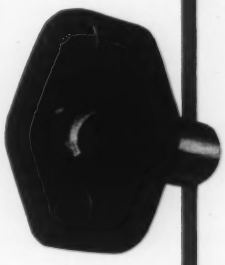
5 practical ways to "streamline"

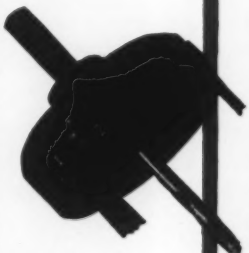
...without sacrificing fastening strength



1. Counterbored holes are the simplest approach to flush surfaces using standard socket cap screws. The advantage of specifying genuine Allen O Head Cap Screws is the greater strength of Allenoy steel... you can use smaller sizes for closer spacing and reduced weight. Call on Allen, too, for *very large* socket-head, precision cap screws — up to 2½ inch diameter.



2. Countersinking enables you to get absolutely smooth external surfaces using Allen O Flat Head Cap Screws. Allen O Cap Screws feature the exclusive Leader Point which makes screw starting easier and guards against thread damage.



3. Button Head Cap Screws produce snag-free unbroken surfaces where countersinking is impractical. Button-head hex sockets are necessarily shallow. In genuine Allen O Button-Head Cap Screws, sockets are cold forged without broaching, in extra strength Allenoy steel... essential protection against stripping the sockets under high torque pressure.

4. A ready made hole tapped in forged steel solves many a design problem. It's called the Allenut. It can be anchored in soft material to assure durable threading, or recessed to permit tightening with an Allen Hex Key.

5. Bright finish, or rust and corrosion resistance call for Allen O Stainless Steel Cap Screws. They are standard stocked items (both NF & NC threads) readily available in a wide range of sizes from Allen Distributors.

YOUR ALLEN DISTRIBUTOR can give you practical help and swift service. For complete information on any technical fastening problem, write our engineering department direct.

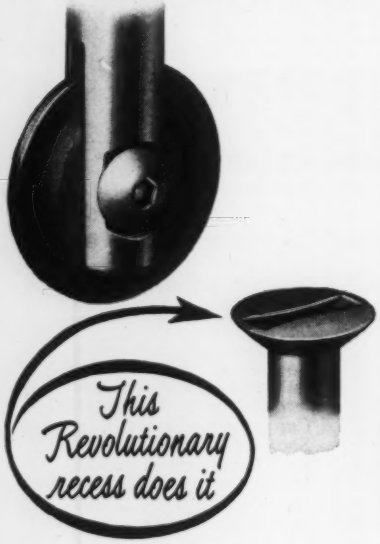
ALLEN HEAD

ALLEN

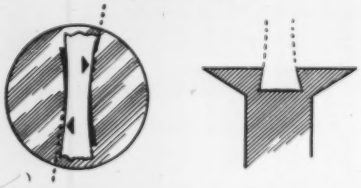
Circle 514 on page 19

hi-torque FASTENERS

give two times torque requirements



Here's why...

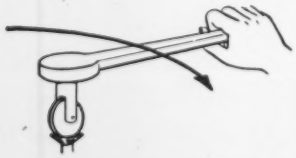


FULL BEARING THRUST

The entire face of the driver blade thrusts against the entire face of the recess, not just a point to point contact.

LOCKED-IN BLADE

The recess is undercut on both sides so a few degrees of torque locks in the driver blade and eliminates outward component of force.



RIGHT ANGLE WRENCHING

Driver can be used 90° to the plane of rotation to exert unlimited torque in insertion or retraction of fastener.

- Shallow recess does not affect head strength in critical materials.
- The combination of high torque values and a shallow recess permits use of small heads.
- Blanks for the Hi-Torque recess are forged in the solid head condition to maintain ideal flow lines.

Write for brochure giving complete specifications and dimensions.

PHEOLL MANUFACTURING COMPANY

Aviation Division

4649 Leahy Street, Culver City, California

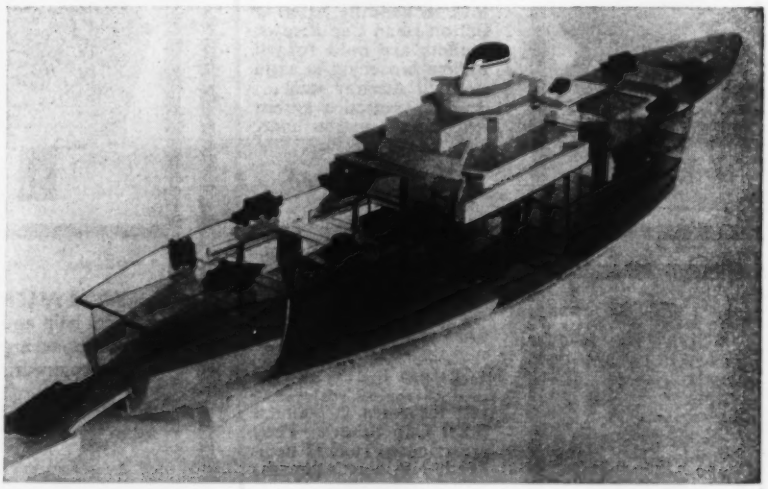
Circle 515 on page 19

Engineering News Roundup

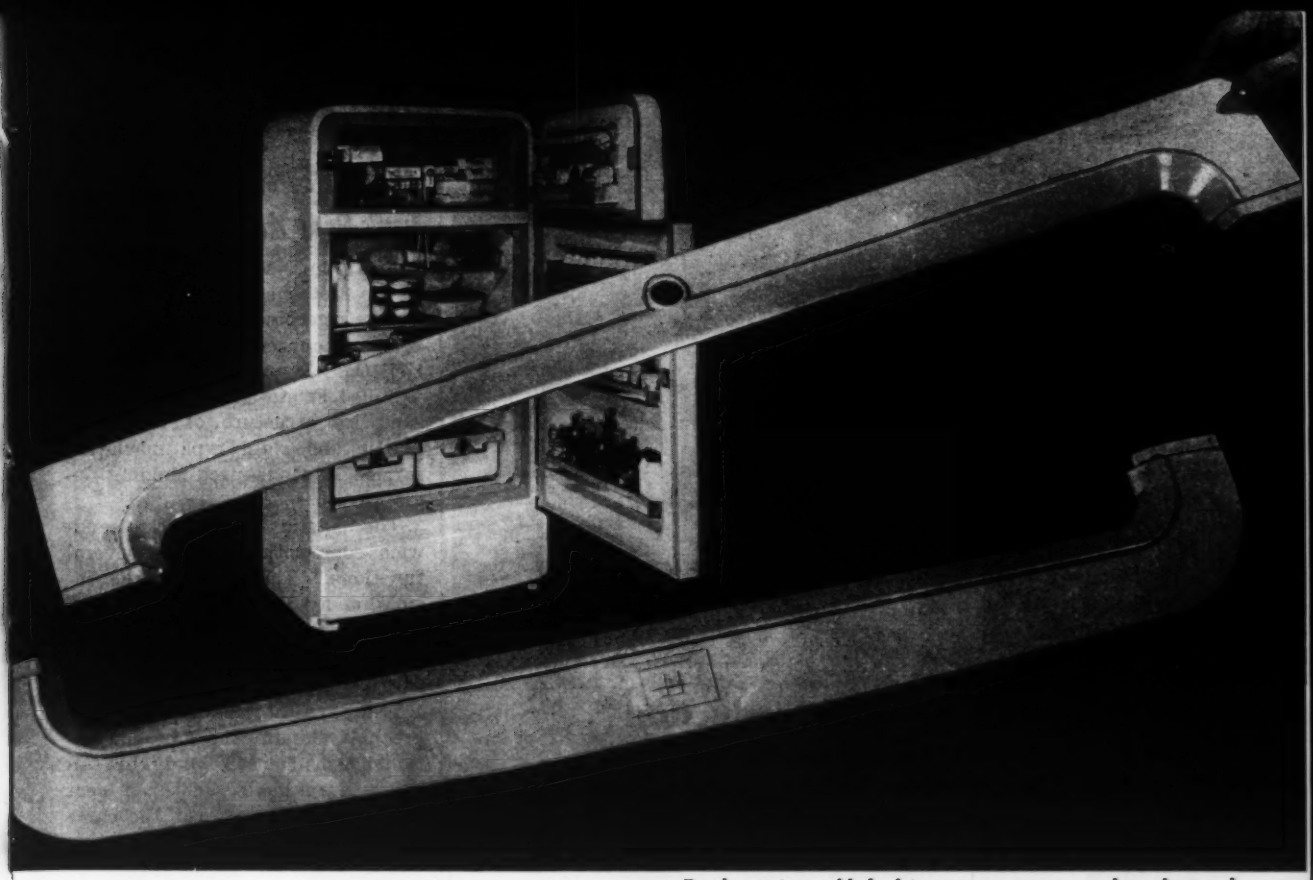
FOUR-WHEELED "MULE", the first new lightweight tactical vehicle to join the Army since the Jeep, has gone into production at Willys Motors Inc. The "Mule" is the first military vehicle to carry a load greater than its own weight, and it has the lowest silhouette—27 in. It is 100 in. long, 46 in. wide, can be transported by helicopter and dropped by parachute. Several of the little trucks can be linked with tow bars and driven by one man to form a "mule train."

(*Continued from Page* 15)

Pressure resistance of the windows depends on size and shape of individual units. One design with ⅜-in. diam and ⅛-in. thickness withstands over 5000 psi.



SEAGOING PARKING GARAGE is this Navy design of a roll-on roll-off cargo vessel. The ship is planned to meet Army requirements for a port-to-port carrier. Vehicles will move on and off the ship under their own power through ports in the side or stern. Vehicle holds are located on five decks, including the weather deck, connected by 14-degree ramps of normal roadway width. The ship could also accommodate general cargo, handled by fork-lift trucks and conveyors operating through stern and side ports.



Breaker strips molded of impact styrene are used on door and door frame of refrigerator made by **Hotpoint Co.**, Chicago 44, Ill.

Why breaker strips for Hotpoint are made from BAKELITE impact styrene

Here are the average properties of BAKELITE Brand Impact Styrene TMD-5151 based on laboratory tests:

Specific gravity* (ASTM D-792-50)	1.04-1.09
Izod Impact, ft/lb/in. of notch ⅛ in. bar (ASTM D-256-47T)	
74 deg. F.	3.5
32 deg. F.	2.0
—13 deg. F.	0.7
Tensile Strength, psi (ASTM D-638-49T)	4,300
Elongation in Tension, %	30
Flexural Strength (ASTM D-790-49T)	no failure
Modulus of Elasticity, psi	375,000
ASTM Heat Distortion (¼ in. thick, 264 psi) Deg. F.	176

*value will vary with color

These breaker strips for the Hotpoint refrigerator withstand day-in, day-out service in hundreds of thousands of homes. They demonstrate the toughness of TMD-5151, the BAKELITE Brand Impact Styrene from which they're molded.

They stand up under the impact of continual slamming at refrigerator temperatures. Their dimensional stability assures a snug fit. Accurately molded details and uniformity of color result in closely-matched sections. The high surface gloss withstands household cleaning solutions.

Learn how to apply the advantages of TMD-5151 to your product designs. Qualified technical assistance is available from Bakelite Company to fit this material to your needs. Consult your plastics molder or write Dept. SE-103.

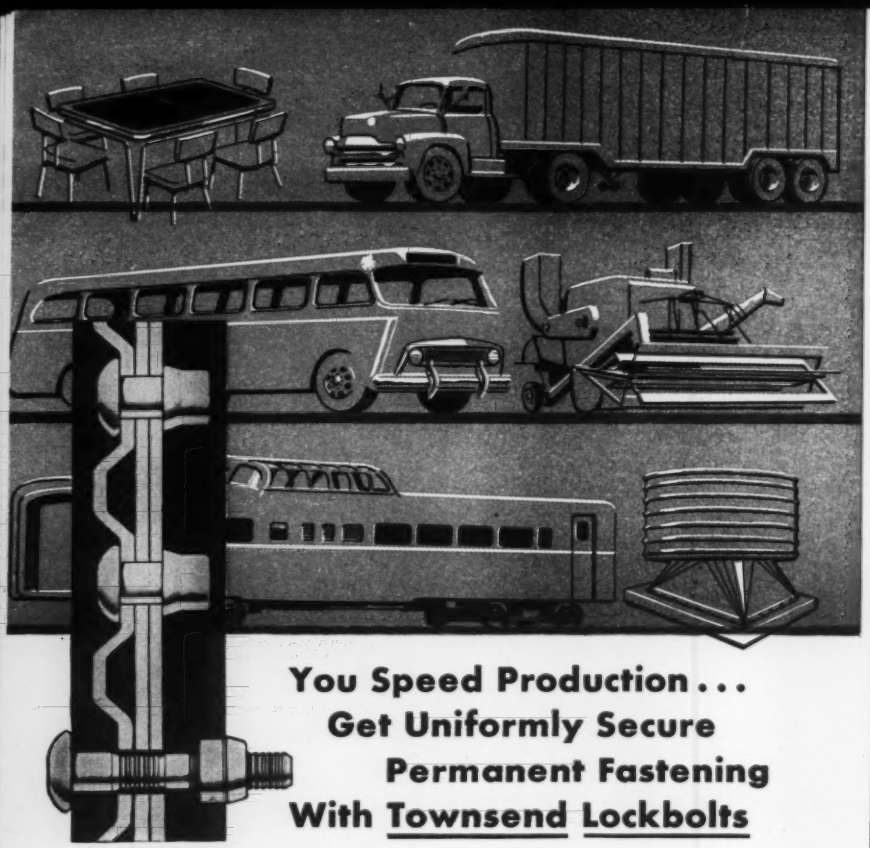
BAKELITE BRAND PLASTICS

BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N.Y.

In Canada: Bakelite Company, Division of Union Carbide Canada Limited, Belleville, Ontario

The term BAKELITE and the Trefoil Symbol are registered trade-marks of UCC

Circle 516 on page 19



**You Speed Production . . .
Get Uniformly Secure
Permanent Fastening
With Townsend Lockbolts**

The Townsend lockbolt provides a quick method of producing uniformly secure fastenings that cannot loosen even under extreme vibration or shock conditions. They combine the advantages of riveting and bolting—eliminate the disadvantages.

Typical users are manufacturers of railroad cars, highway trucks and trailers, buses, farm equipment, industrial ventilators, and furniture. They find that the use of Townsend lockbolts gives them an opportunity to improve their products—reduce unit costs.

These benefits are possible for several reasons. By use of Townsend lockbolts, fewer and less skilled workers can complete an assembly faster than by other methods because the setting action does not depend upon the skill of the operator. The clamping action, or tensile preload is higher than rivets—is more uniform than bolts and nuts. The lockbolt makes possible a more rigid joint because it fills the hole better than other fasteners.

Townsend lockbolts are available in steel and aluminum alloy, in 3/16", 1/4", 5/16", 3/8" and 1/2" diameters, in grip lengths ranging up to 2" in various head styles. Other material and lengths available upon request. They are described in Sweet's design file and in Townsend bulletin TL-101.

For a demonstration at your desk of how to get better, economical fastening with Townsend lockbolts, write on your company letterhead to Townsend Company, P. O. Box 237-E, New Brighton, Pa.

Licensed under Huck patent nos. RE 22,792, 2,114,493; 2,527,307, 2,531,048; 2,531,049.

Townsend
COMPANY • ESTABLISHED 1816
NEW BRIGHTON, PENNSYLVANIA
Sales Offices in Principal Cities
Cherry Rivet Division • Santa Ana, California

Circle 517 on page 19

News Roundup

All-Plastic Refrigerated Truck Body Announced

MILWAUKEE, WIS. — Development of the first one-piece, molded-plastic, refrigerated truck body has been announced recently by the Heil Co.

Called Frigid-Van, the body is a sandwich structure of reinforced plastic and rigid type insulation formed in a one-piece molding operation.

The plastic skins in the sandwich composition perform several functions. They protect the insulation against physical damage, give strength to the structure, and add to the insulation effect of the core material.

Heil says the plastic body walls are half the thickness of conventional construction, and this allows approximately 20 per cent greater load space over the same

DE NECKBONES AM CONNECTED by a modified ball and socket arrangement in Mark III, whose cervical vertebrae were cast by the Investment Casting Co. Neck motion is controlled by bosses that project from the hemispherical top surfaces of the castings and fit into radial slots on the under sides of mating castings. A test dummy by trade, Mark provides physical data on the effect on human beings of crashes and other dangerous circumstances being tested in automobiles.

size conventional body. Since the insulation is hermetically sealed between the sheets of plastic, moisture or vapor cannot penetrate and condense on the insulation and thereby add to expensive dead weight.

Because plastic will not rust or corrode and has impact strength several times that of steel, the Frigid-Van should have a longer life than conventional bodies. Color can be molded in the plastic exterior and thus eliminate the need for repainting during the life of the body.

Inexpensive repairs made possible by a simple patching process and the fact that plastic will not absorb odors are among other advantages of the Frigid-Van.

Meetings

AND EXPOSITIONS

Sept. 10-12—

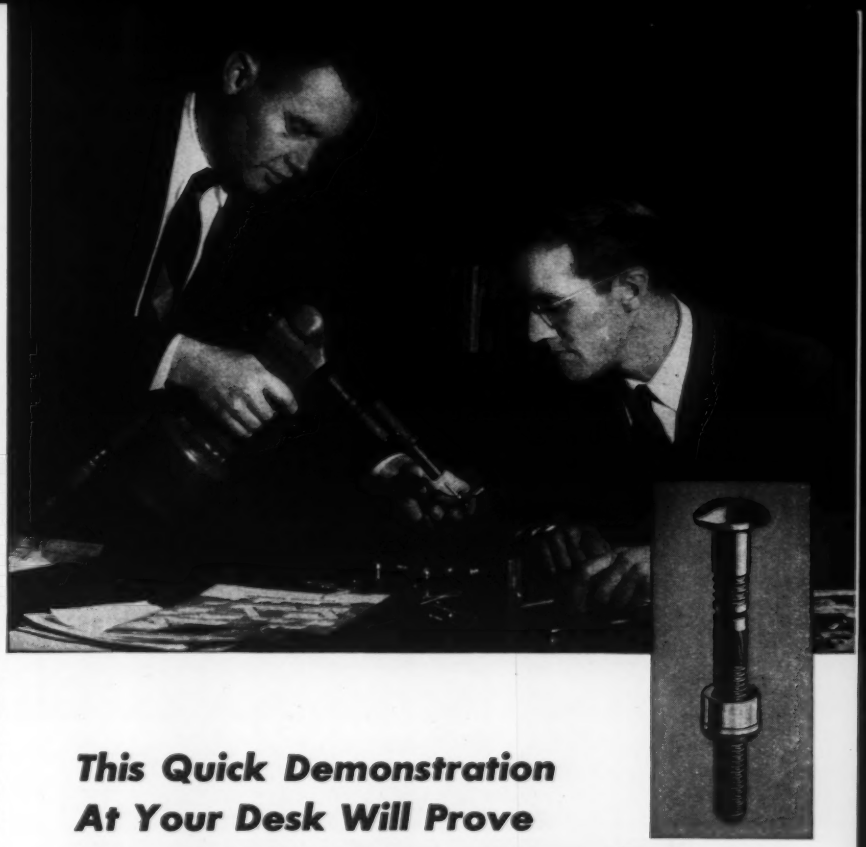
American Society of Mechanical Engineers. Fall Meeting to be held at the Cosmopolitan Hotel, Denver. Additional information can be obtained from society headquarters, 29 W. 39th St., New York 18, N. Y.

Sept. 11-14—

Packaging Machinery and Materials Exposition, to be held at Cleveland Public Auditorium. Sponsors are Packaging Machinery Manufacturers' Institute and the 18th Annual Forum of the Packaging Institute, which will be held September 10, 11 and 12. Additional information can be obtained from exposition headquarters, Suite 759, 1 Gateway Center, Pittsburgh 22, Pa.

Sept. 17-21—

American Society of Mechanical Engineers. Instruments and Regulators Division and Instrument Society of America Exhibit and Joint Conference, to be held at the Coliseum, New York. Additional information can be obtained from society headquarters, 29 W. 39th St.,



This Quick Demonstration At Your Desk Will Prove How To Get Better, Economical Fastening With Townsend Lockbolts

A few minutes of your time invested in watching a simple demonstration of a better fastening method may point the way to savings of thousands of dollars in assembly of your products. The Townsend lockbolt provides a quick method of producing tight, rigid fastenings that cannot loosen even under extreme vibration or shock conditions.

We would like to have a Townsend engineer demonstrate to you and others in your organization how these lockbolts combine the advantages of riveting and bolting—eliminate the disadvantages. He will show you that installation is fast—that fewer workers can complete an assembly in less time—you improve your product—achieve a lower installed cost.

You will be able to see why the clamping action, or clinch, of Townsend lockbolts is higher than rivets—is more uniform than bolts and nuts. The demonstration will explain how the lockbolt fills the hole better than other fasteners—makes possible a more rigid joint and provides an effective liquid seal.

Townsend lockbolts are available in steel and aluminum alloy, in 3/16", 1/4", 5/16" and 3/8" diameters, in grip length ranging up to 2", in various head styles.

For a demonstration on how to speed production, get tight, secure, permanent fastening with Townsend lockbolts write on your company letterhead to Townsend Company, P.O. Box 237-E, New Brighton, Pa.

Licensed under Huck patent nos. RE 22,792; 2,114,493; 2,527,307; 2,531,048; 2,531,049.

THE FASTENING AUTHORITY

Townsend

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Sales Offices in Principal Cities

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Circle 518 on page 19

no need to over-tax your production facilities

Complex assemblies such as this Y-4 bombsight used in B-47 Stratojets are taken in stride at General Mills. This precision instrument has 3,433 parts, nearly 2,000 of them in this head-end assembly alone.

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Send for this Fact-Packed New Booklet — It describes and pictures our facilities, shows our products, names our customers. Write Mechanical Division, Dept. MD8, 1620 Central Ave., Minneapolis 13, Minn.

MECHANICAL DIVISION OF General Mills

Circle 519 on page 19

News Roundup

New York 18, N. Y.

Sept. 17-21—

Instrument Society of America. Eleventh Annual International Instrument - Automation Conference and Exhibit, to be held at the Coliseum, New York. Additional information can be obtained from society headquarters, 1319 Allegheny Ave., Pittsburgh 33, Pa.

Sept. 17-21—

Illuminating Engineering Society. National Technical Conference to be held at Hotel Statler, Boston. Further information can be obtained from society headquarters, 51 Madison Ave., New York 19, N. Y.

Sept. 17-22—

American Society for Testing Materials. Second Pacific Area National Meeting and Apparatus Exhibit to be held at Hotel Statler, Los Angeles. Additional information can be obtained from society headquarters, 1916 Race St., Philadelphia 3, Pa.

Sept. 23-26—

American Society of Mechanical Engineers. Petroleum - Mechanical Engineering Conference to be held at the Statler Hilton Hotel, Dallas, Tex. Further information can be obtained from society headquarters, 29 W. 39th St., New York 18, N. Y.

Sept. 24-25—

Fifth Annual Industrial Electronics Symposium to be held at the Manger Hotel, Cleveland. Sponsors are Institute of Radio Engineers and American Institute of Electrical Engineers. Further information can be obtained from R. C. Rogers, Associate Editor, MACHINE DESIGN, Penton Bldg., Cleveland 13, O.

Sept. 25-28—

Association of Iron and Steel Engineers. Iron and Steel Exposition and Convention, to be held in the Public Auditorium, Cleveland. Additional information can be obtained from association headquarters, 1010 Empire Bldg., Pittsburgh 22, Pa.

Oct. 1-3—

National Electronics Conference and Exhibition to be held at the Hotel Sherman, Chicago. Sponsors are American Institute of Electrical Engineers, Illinois Institute of Technology, Institute of Radio Engineers, Northwestern University and University of Illinois. Further information is available from conference headquarters, 84 E. Randolph St., Chicago 1, Ill.

Oct. 1-5—

American Institute of Electrical Engineers. Fall General Meeting to be held at the Morrison Hotel, Chicago. Further information can be obtained from institute headquarters, 33 W. 39th St., New York 18, N. Y.

Oct. 2-6—

Society of Automotive Engineers Inc. National Aeronautic Meeting, Aircraft Production Forum and Aircraft Engineering Display to be held at Hotel Statler, Los Angeles. Further information can be obtained from society headquarters, 29 W. 39th St., New York 18, N. Y.

Oct. 3-5—

Standards Engineers Society. Fifth Annual Meeting to be held at Hotel Willard, Washington, D. C. Further information can be obtained from society headquarters, P. O. Box 281, Camden 1, N. J.

Oct. 4-5—

Magnesium Association. Annual Meeting to be held at the Drake Hotel, Chicago. Additional information is available from association headquarters, 122 E. 42nd St., New York 17, N. Y.

Oct. 8-10—

American Society of Mechanical Engineers. ASME-ASLE Third Lubrication Conference to be held at Chalfonte-Haddon Hall, Atlantic City, N. J. Further information can be obtained from society headquarters, 29 W. 39th St., New York 18, N. Y.

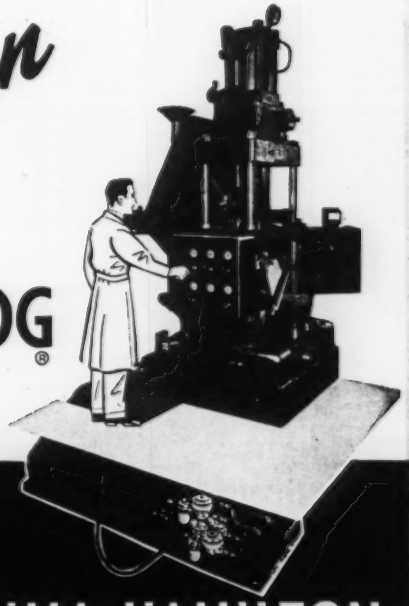
Oct. 8-12—

National Metal Congress and Exposition to be held at the Public Auditorium, Cleveland. Partici-

Norgren

MICRO-FOG®

Lubricates



BALDWIN-LIMA-HAMILTON

Compacting Presses

17 Units of Norgren Equipment Pressurize and Lubricate 9 Cylinders, Clutch and Brake . . .

The Press Department of the Baldwin-Lima-Hamilton Corp. manufactures compacting presses for use in the powdered metal field.

The 50 and 100 ton presses are each equipped with 17 individual Norgren units—an air line filter, pilot-controlled pressure regulators and MICRO-FOG Lubricators, serving 9 cylinders, the clutch and brake.

The Norgren MICRO-FOG Lubricators automatically apply a protective film of oil—just the right amount, not too much, not too little—for the most efficient lubrication of the air-operated parts of of the Baldwin Press. There are never periods of insufficient or excessive lubrication. Maintenance-saving features of these lubricators include a sight feed dome that permits accurate adjustment of the oil feed and gives visual indication of the proper operation of the lubricator, and a visible oil reservoir that shows at a glance when the oil supply needs replenishing.

In addition to lubricating air-operated equipment, Norgren MICRO-FOG is widely used in industry for lubricating bearings, gears, chains and other machine components. One MICRO-FOG Lubricator can completely lubricate even a large machine—as much as 1000 bearing inches.

Norgren Remote Controlled Regulators Are Sales-Making Design Feature

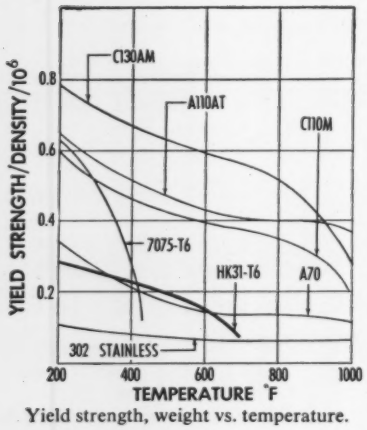
Because 3 feet of the Baldwin Press pictured above is mounted below floor level—including Norgren Pressure Regulators—working air pressure is remotely controlled by Norgren Pilot Regulators mounted in a control panel at the operator's station. This is a big sales feature of the machine, according to Baldwin sales engineers.

MICRO-FOG a Product of C. A. Norgren Co

Call your nearby Norgren Representative listed in your telephone directory, or WRITE FOR NEW CATALOG.

3442 So. Elati St., Englewood, Colo.

Circle 520 on page 19



Yield strength, weight vs. temperature.

For High Strength-to-Weight Ratios at Elevated Temperatures— TITANIUM and MAGNESIUM

The experience, the specialists, the equipment-and-facilities to design and produce the *very difficult* fabrication and assembly work in these and other light metals—you'll find at B&P.

To make this titanium pressurized tank, B&P welds two cylinders. Each is drawn in one operation. Tank withstands 5000 psi pressure.

Magnesium turret enclosure for a bomber. Design, lofting, prototypes, production fabrication and assembly are all done by B&P.

ENGINEERING FACILITIES IN DETROIT AND LOS ANGELES . . Write for Titanium and Magnesium engineering data—also folder on B&P's facilities to handle tough jobs.

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56 A

OFFICES IN NEW YORK, WASHINGTON, DALLAS

Circle 521 on page 19

pants in the scientific sessions will be the American Society for Metals; the American Welding Society; the Institute of Metals Div. of the American Institute of Mining, Metallurgical and Petroleum Engineers; and the Society for Non-Destructive Testing. Additional information can be obtained from show headquarters, 7301 Euclid Ave., Cleveland 3, O.

Oct. 10-11—

Material Handling Institute Inc. Fall Meeting to be held at the Traymore Hotel, Atlantic City, N. J. Additional information can be obtained from institute headquarters, Suite 759, 1 Gateway Center, Pittsburgh 22, Pa.

Oct. 10-12—

Society of Automotive Engineers. National Transportation Meeting to be held at Hotel New Yorker, New York. Further information can be obtained from society headquarters, 29 W. 39th St., New York 18, N. Y.

Oct. 16-18—

Conference on Magnetism and Magnetic Materials to be held at Hotel Statler, Boston, sponsored by the American Institute of Electrical Engineers in co-operation with the American Physical Society, the American Institute of Mining & Metallurgical Engineers and the Institute of Radio Engineers. Further information is available from T. O. Paine, Measurements Laboratory, General Electric Co., West Lynn, Mass.

Oct. 18-19—

National Conference on Industrial Hydraulics. Twelfth Annual Meeting to be held at the Sherman Hotel, Chicago, sponsored by Illinois Institute of Technology. Further information can be obtained from Joseph J. Kowal, Conference Secretary, Armour Research Foundation of Illinois Institute of Technology, 10 W. 35th St., Chicago 16, Ill.

Oct. 22-24—

Purdue University. First Conference on Manufacturing Automation cosponsored by *Automation* Magazine. Additional information may be obtained from Editor, *Automation*, Penton Building, Cleveland 13, Ohio.

Oct. 22-26—

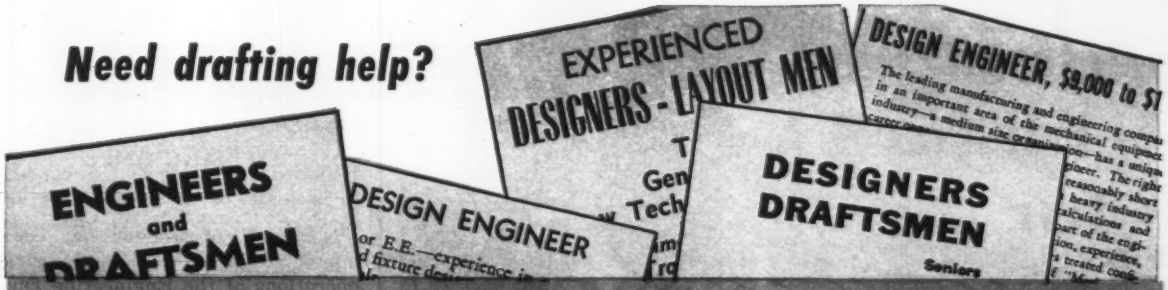
Production Engineering Show to be held at Convention Hall, Philadelphia. Further information is available from Clapp & Poliak Inc., 341 Madison Ave., New York 17, N. Y.

It Never Fails . . .

You've spent four days running stress checks and getting yourself oriented. Now that you know the problem from A to Z . . .

"Julio, I'd like you to meet our new man. Thought we'd break him in on your job. So if you don't mind, I'd like you to incorporate some E.O.'s."

Need drafting help?



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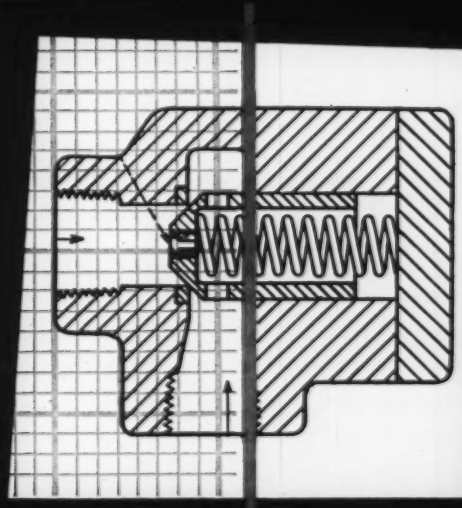

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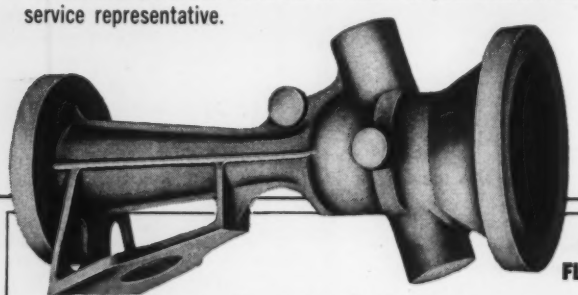
Circle 522 on page 19

DESIGN PARTS FOR THE SHAPE YOU WANT—Investment Casting can produce the most intricately shaped parts with little or no secondary machining required.

CHOOSE THE ALLOY YOU WANT—Investment Castings are produced in any of the ferrous or non-ferrous alloys, including magnesium.

USE THE PROCESS WISELY—Give full consideration to weight, dimensions, tolerances and surface finishes when designing for Investment Casting. Take full advantage of the economies inherent in the process.

CONSULT ARWOOD ENGINEERS—Arwood casting engineers will gladly consult with you on your design and production problems, helping you translate them into finished products. Write for the name of your nearest ARWOOD sales and service representative.



DESIGN FLEXIBILITY

Parts similar to this stainless steel valve body for an air flow controller often require several changes before design is finalized. Due to the relatively low cost of dies and die changes, the investment casting process has proven an inexpensive and flexible method.

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"PIONEERS IN INVESTMENT CASTING"

Circle 523 on page 19

MEN

OF MACHINES

Sidney F. Musselman has been appointed director of engineering operations of the Engineering Div. of American Machine & Foundry Co., New York. Mr. Musselman joined AMF in 1953 and was active in the formation and organization

Sidney F. Musselman

of the Mechanics Research Department in Chicago. In 1954 he was transferred to the company's Greenwich Laboratories as operations manager of a new engineering section. Immediately prior to his new appointment he was project control manager of the Engineering Div. Before joining AMF, Mr. Musselman was associate manager of the Engineering Mechanics Div. of Armour Research Foundation of Illinois Institute of Technology.

Missile Products Corp., a wholly-owned subsidiary of Gladden Products Corp., Glendale, Calif., has named **Walter H. Righter** chief engineer.

Edward T. Keast Jr. has joined Piasecki Aircraft Corp., Philadelphia, as project engineer on the new "Sea Bat," an electronically controlled weapon. He formerly

held a similar position with Vertol Aircraft Corp. For many years, Mr. Keats has been a project engineer on various stabilization systems for helicopters. Previously he was a structures engineer at the Budd Co.

T. J. Evans Engineering Co., Birmingham, has announced the election of **J. K. Hawk** as vice president for engineering.

O. J. Skawden has been named vice president of Sutton Engineering Co. He will continue to serve as chief engineer at the firm's Bellefonte, Pa. plant. Mr. Skawden has been associated with Sutton since 1927.

Circo Equipment Co., Rahway, N. J., has appointed **Walter J. Reinecker** to the newly created post of chief engineer of the sonic division. He will be responsible

Walter J. Reinecker

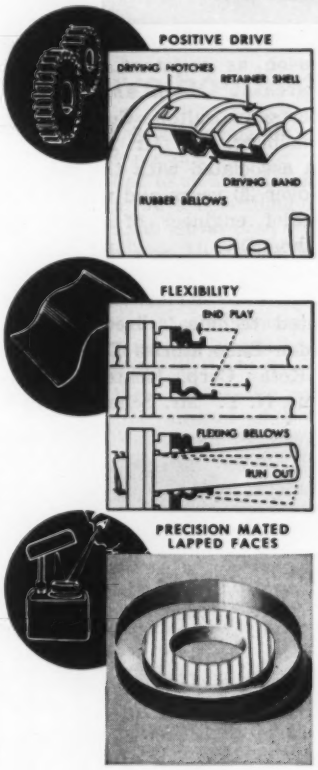
for proceeding with developmental work begun by Circo in the field of ultrasonics.

At the same time the company appointed **Stanford J. Barlett** manager of its Washer Div., with responsibilities including design of metal parts washers and dryers and complete finishing systems.

Robert W. Beal has been named director of development at the Corps of Engineers Research and

JOHN CRANE

Shaft Seal Design With A Purpose!



POSITIVE DRIVE

This gives long seal life. Drive is transmitted through the driving band and washer driving notch which absorb all breakout and running torque. Damaging stresses on the bellows or flexible sealing member are eliminated. Slippage is also eliminated, thus protecting shaft or sleeve against galling.

FLEXIBILITY

Axial and radial misalignment problems are eliminated. Self-adjusting bellows or sealing head automatically compensates for shaft end play or run out. Minimum spring pressure is required for axial shaft movement and uniform spring pressure is maintained during radial shaft movement.

PRECISION MANUFACTURE

Leakproof performance is assured. Washer and seat surfaces are precision lapped to a perfect mate under a patented "John Crane" process.

A SEAL FOR EVERY SERVICE

All "John Crane" Seals are constructed to the particular service requirements . . . from hot or cold water to the most destructive acids, corrosives and gases . . . temperatures up to 1000°F. . . . pressures to 1200 psi. They can be furnished in types and sizes to meet practically any mechanical or dimensional condition.

Request Bulletin S-204-2. Containing full information on "John Crane" engineered shaft seals.

GET COMPLETE DETAILS

Crane Packing Co., 6423 Oakton Street, Morton Grove, Ill. (Chicago Suburb)

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CRANE PACKING COMPANY

Circle 524 on page 19

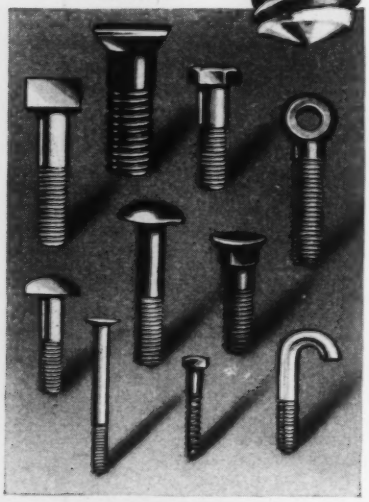
Threaded Specialties

lower cost
EYE BOLTS
by an
exclusive method

Among Pawtucket's many specialty products are these lower-cost eye bolts or "swing" bolts. Pawtucket's exclusive production method keeps cost low, dimensional accuracy unusually high and strength above standard.

Pawtucket eye bolts are made in standard sizes ¼" and larger, or to your specifications. In any size, you can depend on uniform Class 3 fit, if required.

All standard steels, stainless steels and non-ferrous metals, including Titanium



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MANUFACTURING COMPANY
327 Pine St. • Pawtucket, R. I.
THE PLACE TO SOLVE YOUR BOLT PROBLEMS
T.M. REG.
"The Bolt Man"

Circle 525 on page 19

Development Laboratories, Fort Belvoir, Va. Mr. Beal was formerly chief of the Laboratories' mechanical engineering department.

The appointment of **Charles D. Branson** as assistant director of research has been announced by Robertshaw-Fulton Controls Co., Greensburg, Pa. Mr. Branson has been associated with the company for over 20 years and was formerly chief engineer of the Fulton Sylphon Div.

Carl F. Schaefer has been appointed technical director of the Norden Laboratories Div. of Norden-Ketay Corp., located in White Plains, N. Y. Mr. Schaefer will be

Carl F. Schaefer

responsible for all activities of the laboratories, which are mainly concerned with developing control systems for weapons delivery, aircraft and machine tools and advanced communications and test equipment. Mr. Schaefer joined Carl L. Norden Inc. in 1942.

Frederick H. Frantz has been named director of engineering for machine research and development by Ozalid Div. of General Analine and Film Corp., New York. Mr. Frantz joined Ozalid's engineering department in 1947 and has been chief engineer since 1948. He was formerly director of research and development engineering at Stow Mfg. Co.

Reuben P. Snodgrass has been appointed director of flight research by Sperry Gyroscope Co., division of the Sperry Rand Corp., Great Neck, N. Y. He was previously engineering department head for flight research.

The second Elmer A. Sperry Award will be presented to **Donald W. Douglas,** president of Douglas Aircraft Co. Inc. The award is given for "a distinguished engineering contribution which . . . has advanced the art of transportation . . . ." Sponsors are the American Society of Mechanical Engineers, American Institute of Electrical Engineers, Society of Automotive Engineers and Society of Naval Architects and Marine Engineers.

Central Electronic Manufacturers Inc., Denville, N. J., has appointed **Bernard Bernstein** chief engineer of its Electronic Tube Div.

C. E. Gumbert Jr. has been appointed chief engineer of Elbeeco Inc., a subsidiary of Aeroquip Corp., Jackson, Mich. He was formerly associated with the quality control department of the company's Jackson Div.

Formerly assistant director of engineering, **Howard S. Manwaring** has been made director of engineering of International Harvester Co., Chicago.

Charles J. Falk has been appointed manager of engineering for the Distribution Assemblies Dept. of General Electric Co. in Plainville, Conn. Mr. Falk joined GE in 1942 and has been manager of special products design engineering in the company's X-ray department at Milwaukee since June, 1953.

Paul Maker recently joined the Research Laboratories Div. of Bendix Aviation Corp. in Detroit as staff engineer. He will be engaged in advanced research and development of machine tool control systems. Mr. Maker was formerly senior research engineer at Bryant Chucking Grinder Co.

Design data on adhesives

Armstrong

ADHESIVES • COATINGS • SEALERS

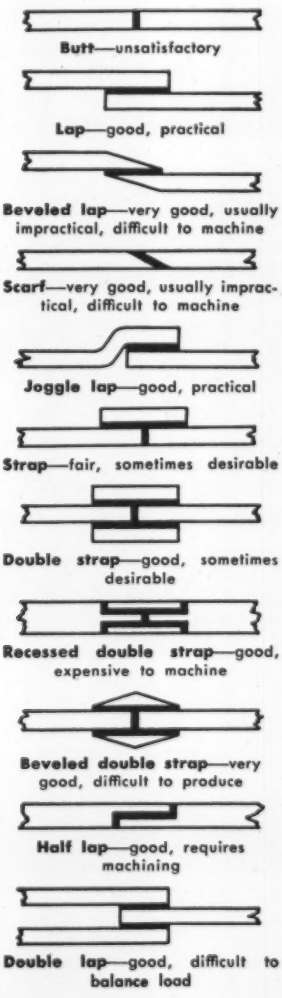
NUMBER FOUR

How to strengthen metal-to-metal joints for flat plates

In order to strengthen any joint to be adhesive-bonded, four basic rules must be kept in mind. These rules are:

1. Make the bonded area as large as possible.
2. Make the maximum proportion of bonded area contribute to strength.
3. Stress the adhesive in the direction of its maximum strength.
4. Minimize stress in the direction in which adhesive is weakest.

Shown below is a variety of flat plate, metal-to-metal joints to which these rules have been applied.


Butt—unsatisfactory
Lap—good, practical
Beveled lap—very good, usually impractical, difficult to machine
Scarf—very good, usually impractical, difficult to machine
Joggle lap—good, practical
Strap—fair, sometimes desirable
Double strap—good, sometimes desirable
Recessed double strap—good, expensive to machine
Beveled double strap—very good, difficult to produce
Half lap—good, requires machining
Double lap—good, difficult to balance load

Adhesive bonding: application of pressure

Effective adhesive bonding always requires some pressure. This pressure may be applied to an assembly in any one of several ways, depending on the nature of the adhesive, design of the part, and its size. Hydraulic presses, hydraulic pads, hydraulic cylinders, air cylinders, spring-loaded jigs, air-filled rubber bags and vacuum bags have all been used satisfactorily.

Whatever the method, though, it must meet these three basic requirements: (1) the amount of pressure should be adequate; (2) pressure should be retained at a constant level; and (3) it should be distributed uniformly over the work.

How much pressure?

The amount of pressure required varies with the kind of adhesive and assembly. Some thermosetting adhesives, for example, require relatively high pressure (as high as 200 psi) for times ranging from 15 minutes to several hours. On the other hand, certain thermosetting epoxy-resin adhesives will form a tight bond at room temperatures with only enough pressure to maintain contact. Contact adhesives require high pressures, but only for brief periods. If in doubt about the amount of pressure, check the adhesive manufacturer's recommendations.

KRAFT PAPER HONEYCOMB CORE is being bonded to sheet aluminum. Panel moves between rubber-covered pinch rolls which deliver uniform pressure. This momentary application of pressure is all that's required for some thermoplastic adhesives.

Note: in some sheet metal assemblies, some pressure may be required to straighten warped sheets and bring them into full contact. This pressure should be added to the bonding pressure recommended by the adhesive manufacturer.

For a pressure device to be satisfactory, it must retain pressure at a reasonably constant level during the curing period, because changes take place during curing which can effectively reduce the applied pressure. Most adhesives flow under pressure. As a result, the over-all thickness of the joint may be reduced and the pressure lowered. Pressure must "follow up" such reduction in thickness. Pressure devices which may hold very tightly at room temperatures may loosen and reduce pressure on the joint at elevated temperatures, due to thermal expansion of the parts. Again, some follow-up is required.

Screw-actuated assemblies like clamps and bolted jigs are not satisfactory when used alone. But if used in conjunction with springs, air-filled rubber pads or any other arrangement that will provide follow-up, screw-type devices will give good results.

Uniform distribution

Uniform distribution of pressure is most important. High and low pressure spots within an assembly can result in lack of uniform contact and differing film thickness—which may result in variability of bond strength. With rigid fixtures or dies, a "pressure pad" like chipboard, rubber-fabric compounds, or glass cloth may have to be interposed between the face of the fixture and the work to equalize pressure. Assemblies bonded in vacuum bags or autoclaves, with the pressure applied directly to the bond and not through fixtures, have excellent pressure distribution.

For more information

Write for a copy of "Armstrong Adhesives, Coatings, and Sealers." Armstrong Cork Company, 8008 Dean St., Lancaster, Penna.

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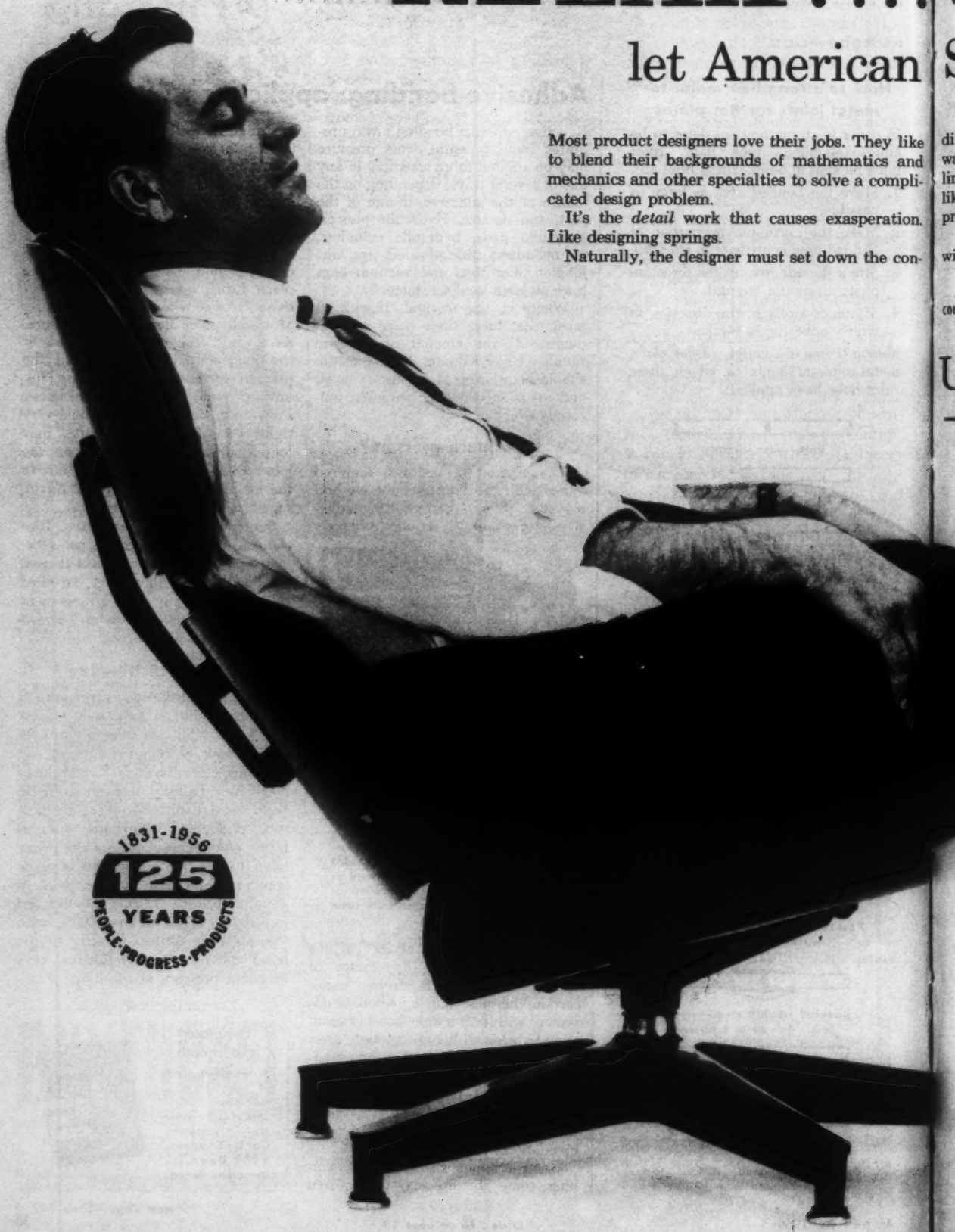
let American



Most product designers love their jobs. They like to blend their backgrounds of mathematics and mechanics and other specialties to solve a complicated design problem.

It's the *detail* work that causes exasperation. Like designing springs.

Naturally, the designer must set down the con-

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when you have a spring problem Steel & Wire worry *for* you

ditions of use. He knows how much stiffness he wants, what fastening system is desirable, the limits of spring travel, corrosion conditions and the like. Now, the plot thickens. Can such a spring be produced, in quantity, at a reasonable price?

It is a rare designer who has concerned himself with these practical spring production problems.

For this reason, American Steel & Wire maintains a staff of *spring engineers* to relieve you of this detail. They may be able to suggest a minor design change, or a different grade of steel, or a different finish that will give you a better spring than you contemplated at a decided savings in cost.

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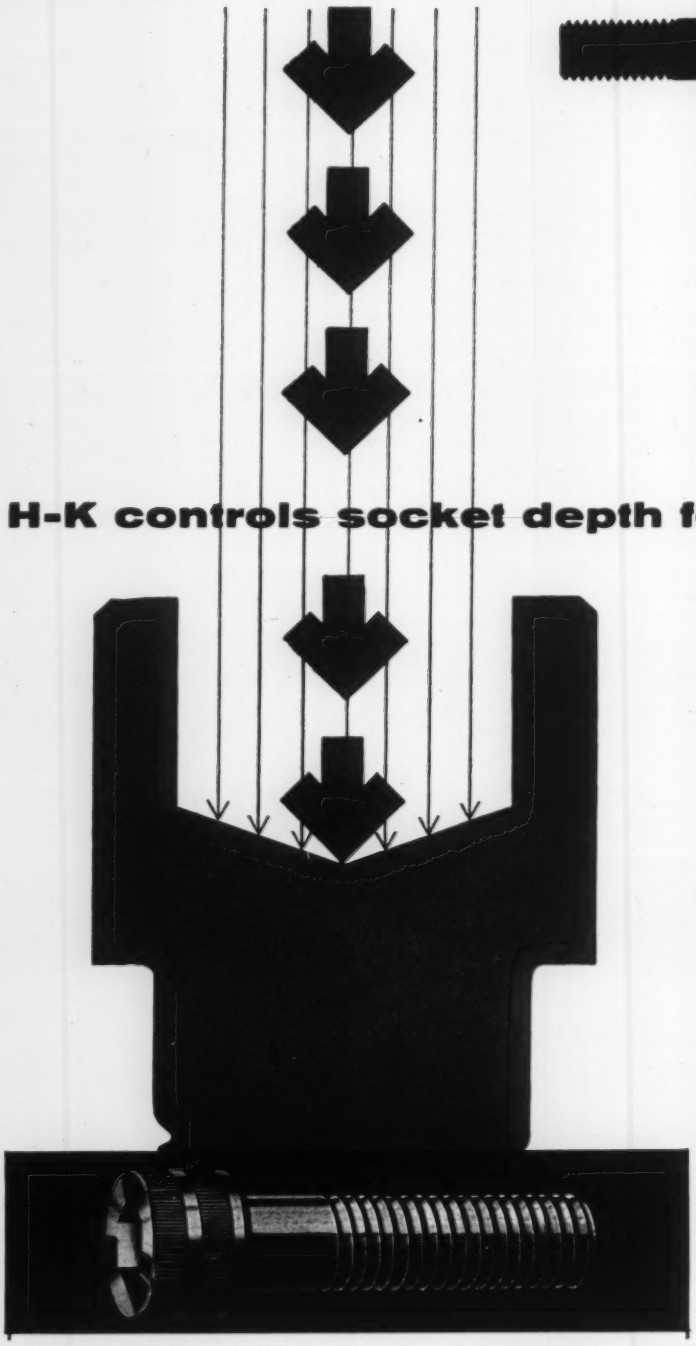
UNITED STATES STEEL

INSIDE INFO FROM HOLO-KROME



THE SECRET'S IN THE SOCKET!

Holo-Krome carefully controls the socket depth. Sockets are deep enough for the hex key to get a firm, solid bite . . . yet scientifically proportioned to give maximum strength to the head of the screw. Accurate design is another plus you get when you specify Holo-Krome.

H-K controls socket depth for tougher screws!

Compare These Other H-K Features!

SHARP HEX CORNERS . . . where the hex key gets a solid grip for firmer fastening.

UNTAPERED WALLS . . . for better key fit, longer key and socket life, even tighter wrenching.

COMPLETELY FORGED SOCKET HEAD . . . no drilling or broaching—metal fibers stay intact for stronger hex sockets.

For the finest in Socket Screw products . . . for revolutionary SAME-DAY SERVICE, the name to remember is Holo-Krome!

LOOK INSIDE A HOLO-KROME SOCKET!

Send in the coupon below and we'll send you FREE an H-K Socket Cap Screw (we've omitted heat treating to let you get a better look at the mirror finish and sharp hex corners under the usual black finish). Look it over carefully, and see for yourself what a real difference H-K quality and skill can make!

Please send me FREE a Holo-Krome Socket Screw for my inspection.

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Circle 528 on page 19

Facing Page—Circle 529→

7
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designed to improve your product

. . . save you material, machining and labor costs

function	basic types				for taking up end-play				
nomenclature	basic		inverted		bowed		beveled		bowed e-ring
series no.	5000	5100	5008	5108	5001	5101	5002	5102	5131
application	Internal for Housing Bores	External for Shafts	Internal for Housing Bores	External for Shafts	Internal for Housing Bores	External for Shafts	Internal for Housing Bores	External for Shafts	External for Shafts
range in.	.250-10.0	.125-10.0	.750-4.0	.500-4.0	.250-1.456	.188-1.438	1.0-10.0	1.0-10.0	.110-1.375
range mm.	6.4-253.8	3.2-253.8	19.0-101.5	12.7-101.5	6.4-37.0	4.8-36.5	25.4-253.8	25.4-253.8	2.8-35.0
features	Tapered design principle permits rings to maintain constant circularity and pressure against bottom of groove.		Inverted construction provides uniform protruding shoulders while maintaining constant circularity when installed in groove.		Bowed construction permits resilient take-up of end-play.		Beveled construction permits rigid take-up of end-play.		Radially applied. Provides large shoulder on small shaft diameter. Bowed construction permits resilient take-up of end-play.

function	for radial assembly			self-locking types					
nomenclature	e-ring	crescent	interlocking	circular self-locking		triangular self-locking	triangular nut	grip-ring	locking prong
series no.	5133	5103	5107	5005	5105	5305	5300	5555	5139
application	External for Shafts	External for Shafts	External for Shafts	Internal for Housing Bores	External for Shafts	External for Shafts	With Threaded Screw	External for Shafts	External for Shafts
range in.	.040-1.375	.125-2.0	.469-3.375	.312-2.0	.093-1.0	.062-.437		.077-.755	.094-.438
range mm.	1.0-35.0	3.2-51.0	11.9-85.7	7.9-50.8	2.4-25.4	1.55-11.1		•	2.4-11.1
features	Radially applied. Provides large shoulder on small shaft diameter. (see 5131)	Applied radially over shaft. Secure against impact and vibration.	Two-piece ring applied radially. Secure against extremely high r.p.m.'s and heavy thrusts.	Installed axially. Requires no groove. Recommended for permanent assemblies exposed to relatively moderate thrusts, impacts or vibrational loading.		Low cost retainer. Makes possible tight assemblies free of end-play on relatively soft shafts.	Flattens under torque. Secures equal load distribution. Replaces lock washer on screw.	Applied axially on shaft. Requires no groove. Exerts considerable frictional hold against axial displacement.	Radially applied. Locks positively in groove. Can be used as shoulder against rotating parts. Replaces nuts and bolts, springs, washers.

WALDES TRUARC®

WALDES KOHINOOR, INC.

manufacturers of Waldes Truarc Retaining Rings, Pliers, and Accessory Tools

47-16 Austel Place • Long Island City 1, New York, U.S.A. • Telephone: EXeter 2-3100

Teletypewriter No.: NY4-2391 (unattended service) • Cable: Waldesian, N.Y.

FUNCTION

Waldes Truarc Retaining Rings are designed to provide shoulders for positioning and retaining machine components on shafts and in housings and bores. Because of the exclusive design principle incorporated in their construction, the rings undergo *circular* deformation rather than *oval* deformation, thereby maintaining constant circularity when expanded and contracted within the limits of normal use. When installed in a groove, Truarc retaining rings provide a secure shoulder against heavy thrust loads and high rpm's—while maintaining constant pressure against the bottom of the groove.

VERSATILITY

Waldes Truarc Retaining Rings are available in 36 functionally different types with as many as 97 standard sizes within a single type. They may be ordered in 5 metal specifications and 14 different finishes. While all of the rings have been designed to serve as retaining shoulders, some have been designed and engineered to perform additional functions far beyond the limits of conventional ring retainers and other methods of industrial fastening. In the scope of their application . . . in the savings they make possible . . . Waldes Truarc Retaining Rings represent a complete departure from conventional fastening devices.

MANUFACTURING EXPERIENCE

Waldes Kohinoor, Inc., pioneered in the development of precision retaining rings and has more than 50 years' experience inventing, developing and manufacturing quality fasteners. Waldes Truarc Retaining Rings are being used with outstanding success in the automotive, electronic and aeronautical industries and in a wide variety of consumer and industrial products. The rings have been standardized by major U.S. industries and Government agencies.

QUALITY CONTROL

At every stage in their manufacture—from raw material to finished product — Waldes Truarc Retaining Rings are inspected and tested carefully by trained specialists using the most modern quality control equipment. Truarc standards are the highest in the industry—your guarantee of consistent, uniform quality.

DESIGN SERVICE

To assist manufacturers and their design and development engineers in the proper selection and use of retaining rings, Waldes Kohinoor, Inc., makes available without charge or obligation the help and experience of the Truarc Technical Service Staff. This group of competent engineers will help you design new products and improve present designs, using standard Truarc retaining rings or specially designed rings to meet your individual requirements. They will design special assembly jigs and fixtures and even help set up an automation assembly operation. We urge you to send in your blueprints today.

FIELD ENGINEERING SERVICE

More than 30 engineering-minded factory representatives and 700 field men are available to you on call. This engineering service can prove invaluable in helping you solve design, assembly and production problems.

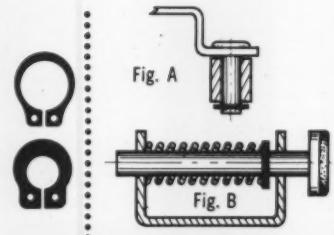
DISTRIBUTION

Truarc rings are available from leading OEM distributors in 90 stocking points throughout the United States and Canada. Wherever you are, Truarc rings are as near as your telephone.

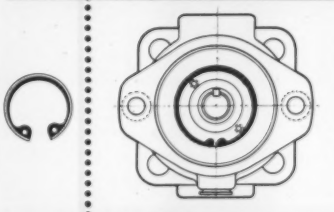
INDEX

- Standard type rings—grouped according to basic function—are described and illustrated on the front cover.
- Actual case histories, showing how important manufacturers have used Truarc rings to improve product design and reduce costs, are illustrated at the right.
- Waldes Truarc accessory and assembly tools, including the Waldes Truarc Grooving Tool, are shown on the back cover.

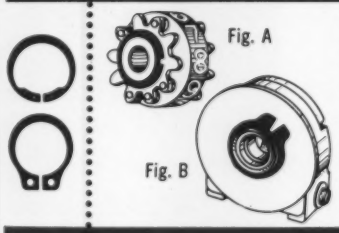
For complete engineering data and specifications, write for retaining ring and grooving tool catalogs.



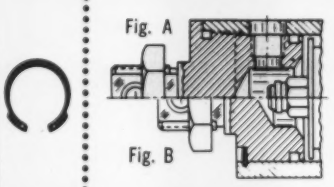
THREE RINGS SAVE $.06 PER UNIT: Two series 5100 rings eliminated six parts, two tapping operations to secure rollers (one shown Fig. A) in Telectro tape recorder. Saving $.04 per unit. One series 5555 grip ring replaced collar and set screw in pressure pad assembly (Fig. B), saving $.02 per unit. Telectro saved $.23 in five sub-assemblies by using Truarc.



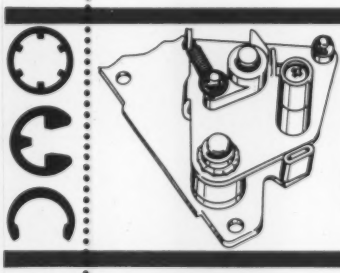
RING REPLACES CAST RETAINER PLATE: Shaft seal sub-assembly of Denison pump-motor was held together by cast retainer plate, four socket head cap screws. Five pieces replaced by one series 5002 beveled ring for weight saving of 1 lb.



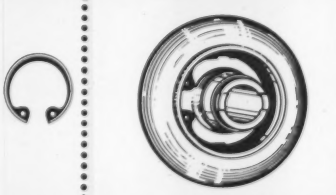
RINGS ELIMINATE SCRAP LOSS: One-piece dial assembly of Monroe Calculator was spun together with high scrap loss. Two-piece unit (Fig. A) uses series 5108 ring, cuts loss almost 100%. Collector disc (Fig. B) formerly was riveted. One Truarc series 5100 ring replaces rivets, saves labor and materials.



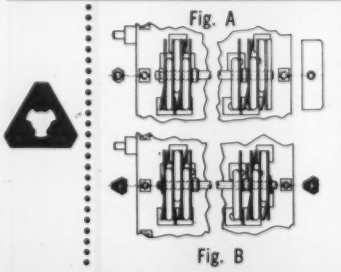
TWO RINGS SAVE $3.26 PER UNIT: A. K. Allen air cylinder used thread-secured head (Fig. A) requiring costly tapping, chasing and assembly. Two series 5008 inverted rings were substituted (Fig. B) for more compact design, labor and material savings of $3.26 per unit.



FEWER PARTS, FASTER ASSEMBLY: Viewlex slide changer uses three type Truarc rings in actuating plate and pawl assembly—series 5105 circular self-locking ring, series 5133 E-ring and two series 5103 crescent rings. They speed assembly, eliminate parts, cut rejects.



BEVELED RING ELIMINATES TAPPING: American Hardware Corp. uses Truarc series 5002 beveled ring in heavy duty cylindrical lock. Ring couples knob to knob shank, eliminating two screws, two tapped holes. Beveled ring takes up end play, provides stronger assembly, greater accuracy.



TRIANGULAR RETAINERS SAVE $.265: To secure thermal tubes in Grinnell heater, threaded tie rod was used with jam nut and drilled and tapped cast iron tube rest (Fig. A). With Truarc (Fig. B), two series 5305 triangular retainers hold tubes securely without grooves, threads or nuts. Saving cut costs 52%, or $.265 per unit.

SPD 20M 9-55 RA

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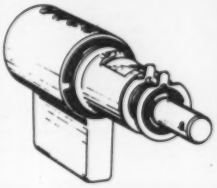
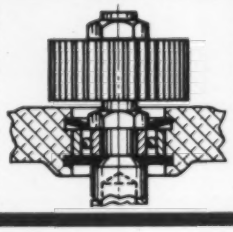
WALDES TRUARC RETAINING RINGS

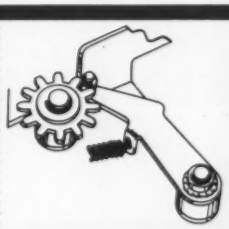
RING ELIMINATES HEAT FORMING: Lens knob assembly on Ansco camera used washer and heat forming operation to flatten plastic pin and lock pivot in position. Series 5105 self-locking ring replaces washer, eliminates heat forming. Ring, which requires no groove, may be removed without damage to knob.



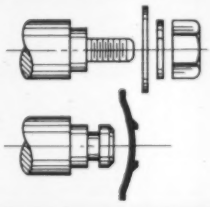
RINGS CUT DISASSEMBLY COSTS: Knob-unlocking mechanism of American Hardware lock uses Truarc series 5133 E-ring as spring retainer, series 5108 inverted ring for retaining cylinder plug. Re-usable rings permit disassembly for maintenance, eliminate rejects.



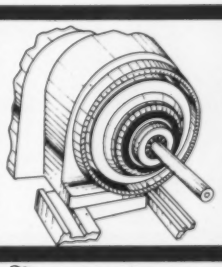
MACHINING ELIMINATED, COSTS CUT: Bearing in Dumore drill is secured by one series 5000 ring, one series 5001 bowed ring which takes up accumulated tolerances. Grooves turned, housing rough bored in one operation. Alternate method required two additional machining operations.



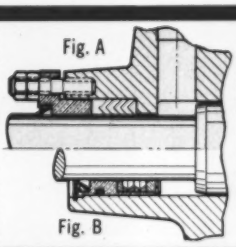
E-RINGS REPLACE SHOULDER SCREWS: Detent lever assembly of Viewlex slide changer uses three series 5133 E-rings to retain rollers and gear. Rings replace shoulder screws, eliminate tapped holes. Radial application speeds assembly.



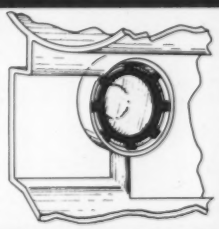
TWO RINGS REPLACE SIX PARTS: Two series 5139 locking-prong rings replace two spring washers, two lock washers, two nuts. Smaller grooved shaft substituted for bolt, eliminating expensive threading at each end and need for skilled labor in assembly.



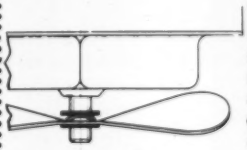
RING REPLACES LOCKNUT: Truarc series 5107 interlocking ring locks handwheel assembly securely on impact sleeve of Jacobs chuck. Eliminates tapping, saves 7/32" in over-all length. Chuck's top speed: 5,000 RPM; Truarc ring balanced to withstand 50,000 RPM.



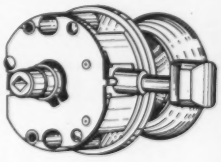
ONE RING SAVES $2.84 PER UNIT: Hydraulic Accessories Co. uses single series 5008 inverted ring to hold Monopak cartridge in cylinder head. Old design (Fig. A) required costly hand packing and adjustment. With Truarc (Fig. B) stuffing box is smaller, weighs 2⅛ lbs. less.



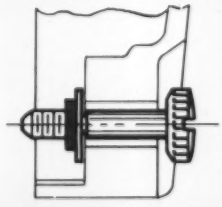
RING AVOIDS COSTLY REJECTS: Rear lens of Ansco reflex camera was secured by heat forming tabs on plastic body. Loose or chipped elements caused frequent loss of both parts. Self-locking series 5005 ring holds lens securely, cuts rejects, permits lens to be removed without destroying body.



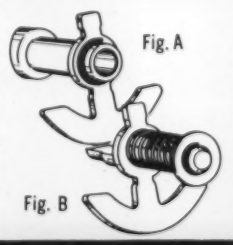
TWO GRIP RINGS SAVE $.07 PER UNIT: In motor fan assembly of Telectro tape recorder, two series 5555 grip rings, used with bowed washer, replace collar and set screw, eliminating costly staking operation. Rings also act as safety clutch, allow fan to slip if obstructed.



RING REPLACES NUT AND WASHER: Main shaft of Chesler lock was secured by nut and washer. Parts replaced by one series 5100 ring which quickly snaps over shaft, eliminating costly threading and time-consuming tightening operations. Saving $5.28 per 1000 units.



RING IN FLASH GUN SAVES $7.06/M: Screw in Ansco camera flash gun was secured by sleeve pressed into hole of plastic cover. Assembly was difficult, time consuming. Truarc series 5133 E-ring, applied radially, quickly snaps onto unthreaded screw shank. Labor saving $7.06 per 1000 units.



CRESCENT RINGS IMPROVE DESIGN: American Hardware lock uses series 5103 crescent rings to save labor and maintenance, improve performance, eliminate rejects. Spindle sub-assembly (Fig. A) has two rings as locating flanges for rollback; sub-assembly (Fig. B) uses one ring as spring retainer, washer locating shoulder.

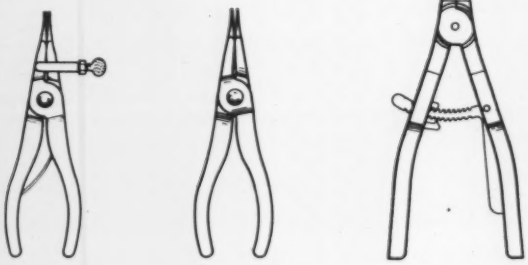
NEW

A new external self-locking ring known as the Series 5115 has been developed which provides a higher thrust load capacity and a greater range of shaft tolerances. Write for samples and additional information.

WALDES

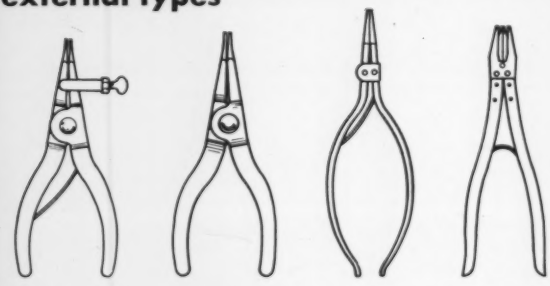
WALDES TRUARC PLIERS

internal types

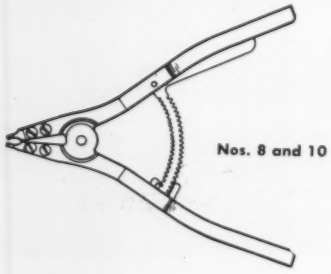


Nos. 1, 3 and 5 | Nos. 21, 23 and 25 | Nos. 7 and 9

external types

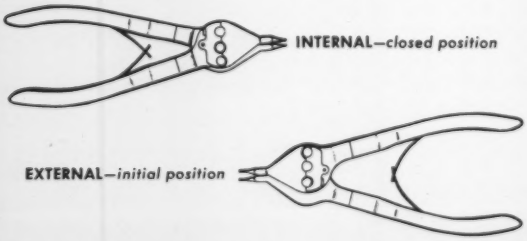


Nos. 2, 4 and 6 | Nos. 22, 24 and 26 | No. 0 | No. 00

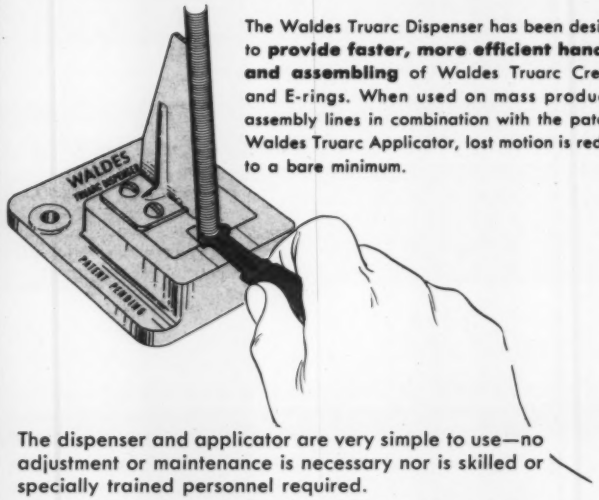


Nos. 8 and 10

universal types 3—4



WALDES TRUARC DISPENSERS & APPLICATORS



The Waldes Truarc Dispenser has been designed to **provide faster, more efficient handling and assembling** of Waldes Truarc Crescent and E-rings. When used on mass production assembly lines in combination with the patented Waldes Truarc Applicator, lost motion is reduced to a bare minimum.

The dispenser and applicator are very simple to use—no adjustment or maintenance is necessary nor is skilled or specially trained personnel required.

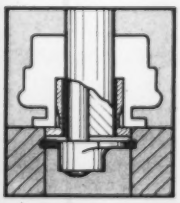
Waldes Truarc Crescent (series 5103) and E-rings (series 5133) are available packed on stackrods specifically for use with the dispenser.

WALDES TRUARC GROOVING TOOL

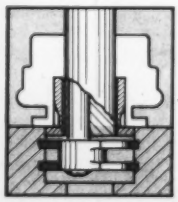
The Waldes Truarc Grooving Tool is an exceedingly versatile tool offering an unsually wide range of possibilities for precision cutting of internal recesses in housings and bores, far beyond the scope and limitations of conventional recessing tools.

The Waldes Truarc Grooving Tool can be used efficiently in drill presses, lathes, or any machine tool equipped with a collet or a chuck. (It is a practical tool for use with a portable drill especially where the workpiece, a boiler plate for example, cannot easily be moved and placed on a machine tool for re-machining.) It will perform equally well whether the tool itself or the part being machined rotates in the machining operation.

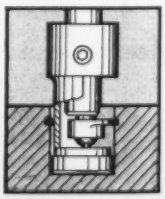
Designed for precision cutting of *concentric* grooves or recesses in bores or housings, the tool can be adjusted easily and will cut grooves within close tolerances. It is an ideal production tool of high efficiency *even when operated by unskilled labor.*



locating groove from top of bore



locating double groove from top of bore



locating groove from bottom of bore with bottom adaptor

WALDES TRUARC®

(Aluminum Company of America photo).

At one stroke this press can forge pieces 10′ wide or 24′ long. It can change a 2,000-pound aluminum slab into a complicated aircraft component... saving material as well as machining and assembly time. Cast and forged nickel alloy steels provide the strength and toughness needed in columns, cylinders, die-block holders and dies of this giant machine. Among the first of the facilities in the U. S. Air Force Heavy Press Program, this unit is a notable engineering achievement of United Engineering & Foundry Co., Pittsburgh, Pa.

Nickel alloy steels strengthen huge press for 35,000-ton squeeze

EIGHT 200,000-POUND FORGINGS of steel fortified with 2¼% nickel! That's what was specified to give this mammoth press essential strength. Used as four 2-column units, these forgings are subjected to the tremendous force of 35,000 tons.

Nickel alloy steel provides the level of strength and notch toughness required. These massive columns are each 61′ high and 34″ in diameter. Whenever a component's size restricts methods of heat-treating, or permits forging only limited portions at a time, improved strength and elastic properties depend particularly upon correct alloy content.

Nickel alloyed steels are used for still other parts that encounter high stresses and loads.

Dies and die holders gain needed stamina from additions of nickel. Among the largest steel castings ever used in press construction, the top and bottom die holders of this press are nickel-chromium-molybdenum steel approximating the 4340 composition. Each measures 26′ by 12′ by 25″ and weighs 350,000 pounds.

In many a metal, you can improve specific properties by use of nickel alone or in combination with other alloy elements. When you seek the solution to a metal problem, let us give you the benefit of our wide practical experience.

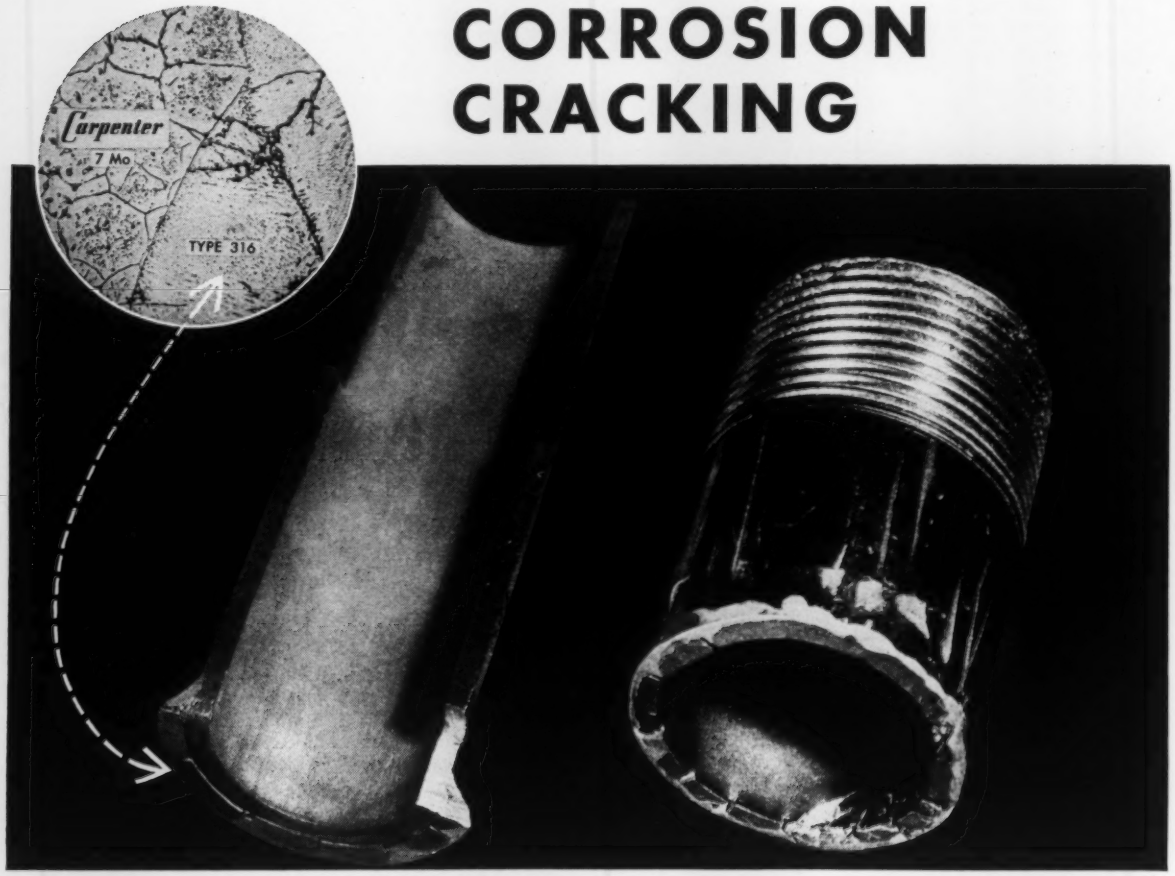
Send the details of your difficulty for our suggestions. Write us now.

INCO TRADE MARK **THE INTERNATIONAL NICKEL COMPANY, INC.** 67 Wall Street New York 5, N. Y.

Circle 530 on page 19

For cost-saving control of...

STRESS CORROSION CRACKING



Carpenter 7Mo Stainless Tubing & Pipe

Take a closer look at the above section of Carpenter 7Mo Stainless Pipe welded to a Type 316 fitting. See how stress corrosion cracking has ruined the fitting, just as it has destroyed the piece of stainless pipe at right.

Note how the cracks in the fitting stop abruptly when they reach the 7Mo pipe. And this pipe has already outlasted three such fittings. The photomicrograph shows the unmistakable proof.

If you have conditions where chlorides, caustic or sulphite solutions are present, Carpenter 7Mo's excellent resistance to general corrosion, pitting and stress corrosion cracking may prove to be a real cost-saver. Let's discuss your particular application now.

The Carpenter Steel Company
Alloy Tube Division, Union, N. J.

Export Dept.: The Carpenter Steel Co., Port Washington, N. Y.—"CARSTEELCO"

Write for this Carpenter 7Mo Technical Bulletin.

Carpenter

more than corrosion resistance

Stainless Tubing & Pipe

Circle 531 on page 19

NOW...

You Can Cut Costs with

THE FERRY CAP

Countr-bor®

SCREW

Used in *standard* counterbored holes and for other socket head screw applications, the Countr-Bor Screw offers important advantages:

Faster wrenching—faster assembly
Using *standard* wrenches
Externally wrenched, it *"tightens tighter"*
In fact, *double savings*—savings in
(1) Cost of product and (2) Cost of assembly
Made of alloy steel—maximum strength
Better appearance

On the market only a comparatively short time, the Countr-Bor has met with the hearty approval of designers, engineers, and production men in solving tough assembly problems and speeding production.

Send for samples.

You'll receive prices, complete information and samples promptly upon request.

Any type socket wrench handle with standard 12-pt. socket is used for counterbored applications.

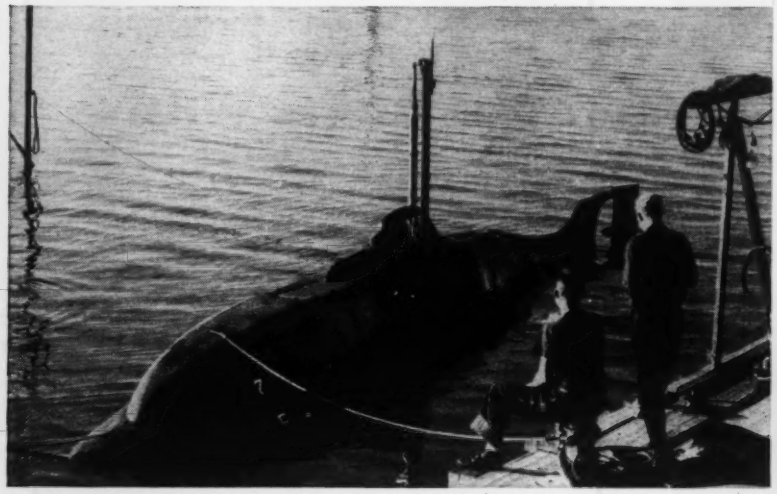
Ferry Cap Countr-Bor Screws
PATENT APPLIED FOR
MANUFACTURED SOLELY BY

THE FERRY CAP & SET SCREW COMPANY
2165 SCRANTON ROAD • CLEVELAND 13, OHIO

Circle 532 on page 19

★ Control Components Digest ★

News and notes on resistors, rheostats, relays, motor controls, dimmers and other control components



FIRST TEST DIVE, on a leash, for new midget sub. Fairchild engineers stand by. She passed this and other tests and was turned over to Navy.

New 4-man midget sub joins Navy

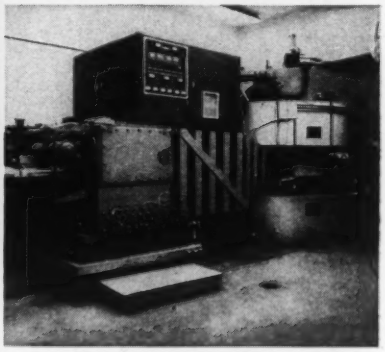
Only 50 feet long, but packing a mighty wallop, the USS X-1, a new midget submarine has just been preliminarily accepted by the U. S. Navy from the builders, Fairchild Engine Division of Fairchild Engine and Airplane Corporation, Deer Park, Long Island.

The 25-ton X-1 carries a 4-man crew, can dive under or cut through steel nets protecting harbors, and sneak up rivers and canals to attack power plants, bridges and dams.

And, among the many design features contributing to the striking power of this new Naval weapon, you'll find reliable Ward Leonard controls for the electric drive—just one of the ways Ward Leonard products are aiding national defense.

75-ton shield door gets fingertip control

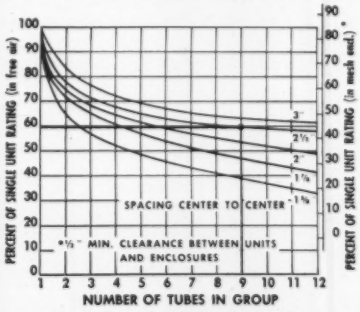
Centralized Ward Leonard motor controls slide the massive shield door for this modern cyclotron into place for research experiments at Brookhaven National Laboratory, Upton, Long Island, N. Y.



Made of concrete with steel support, and weighing 75 tons, the 5- by 8- by 12-foot door protects personnel from effects of radiation when deuterons (the nuclei of heavy hydrogen) are accelerated to an energy of 20 million electron volts.

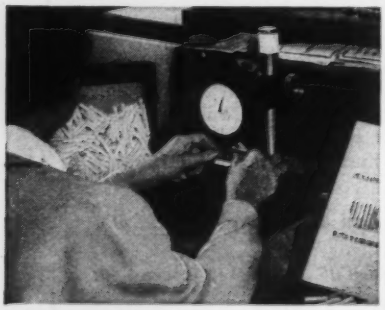
Easy derating for group-mounted resistors

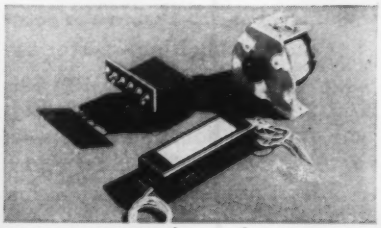
This family of curves will help the designer allow for mutual heating of resistors mounted in close proximity. It's typical of the practical design data you'll find in Ward Leonard's 65-page Catalog 15. Write for your free copy today. 6.8



100% inspection here!

No statistics, no probability theory in this 100% check! She's measuring OD and concentricity of ceramic resistor cores—just two details in Ward Leonard's rigorous and continuous quality control. But, it's checking details like these on every single unit that gives Ward Leonard products their reputation for accuracy, stability and long life.



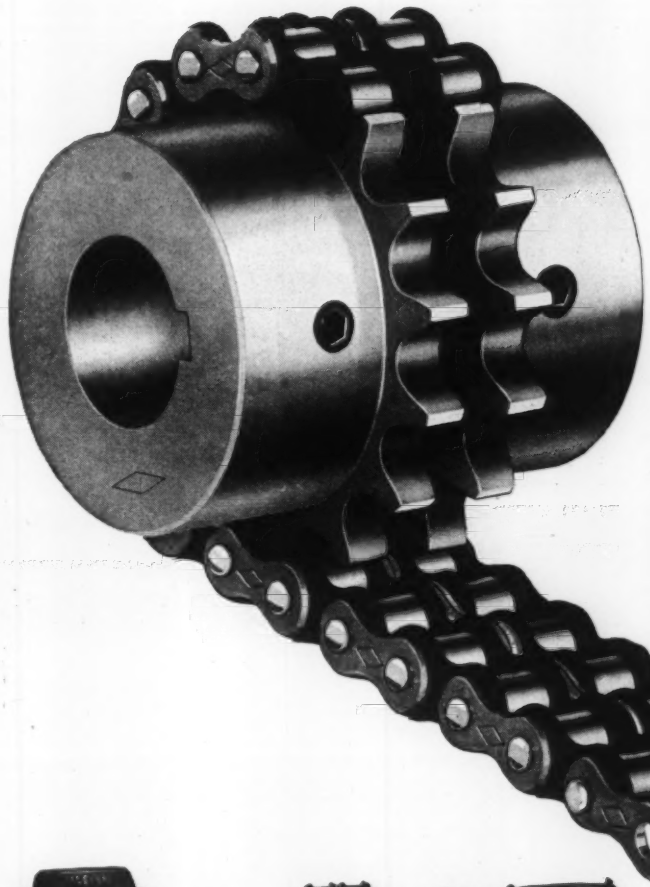


BASIC COMPONENTS for new dimming system.

New 500-to-1 dimmer for fluorescents

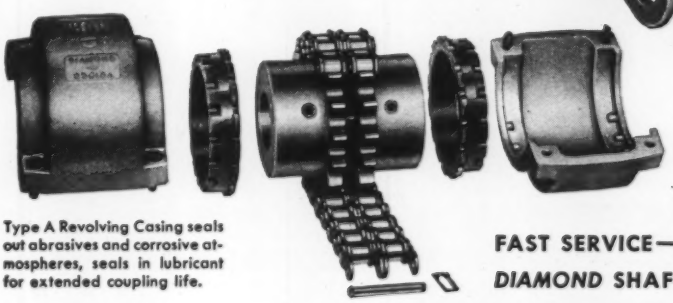
A new Ward Leonard dimming system for hot-cathode 40-watt T-12 fluorescent lamps handles up to 140 lamps with a dimming range of 500 to 1. Simple and non-electronic, the new dimmer is designed for control of cove lighting, luminous ceilings and multiple lamp fixtures in theatres, auditoriums, churches, offices, restaurants, and night clubs. Dimmer circuit output is unaffected by change in connected lamp load. For complete data, write for bulletin 76F.

WARD LEONARD ELECTRIC COMPANY
58 SOUTH ST., MOUNT VERNON, N. Y.
Result-Engineered Controls Since 1892
RESISTORS · RHEOSTATS · RELAYS · CONTROLS · DIMMERS



FLEXIBLE COUPLINGS—
FRACTIONAL TO HUNDREDS
OF HORSEPOWER
IN STOCK **AT YOUR**
DIAMOND DISTRIBUTOR

DIAMOND



Type A Revolving Casing seals out abrasives and corrosive atmospheres, seals in lubricant for extended coupling life.

FAST SERVICE—HIGH CAPACITY—SUPERIOR QUALITY
DIAMOND **SHAFT COUPLINGS**

◆ End to end shaft connections can be made quickly, inexpensively and in minimum space with Diamond Flexible Couplings. Load is carried at the greatest radius and distributed evenly over the entire length of chain for maximum capacity and life. Moderate angular and parallel misalignment as well as shaft end float are absorbed in the clearances between chain and sprocket teeth.

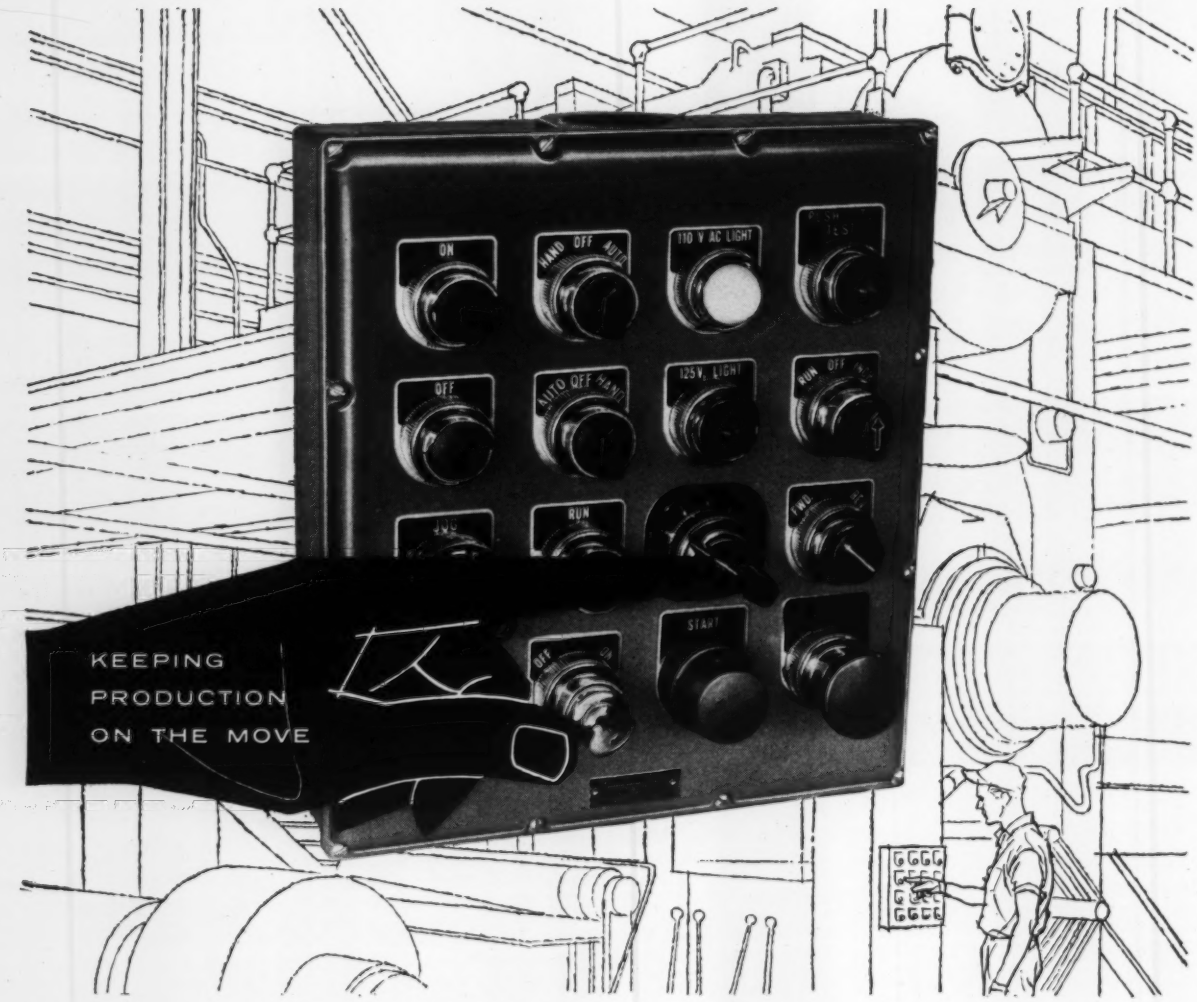
◆ You probably have many applications where the use of Diamond Flexible Couplings can provide improved operation and long dependable service. Call your nearest Diamond Distributor for immediate service. His name is in the yellow pages of the telephone book under the heading Chains or Chains-Roller.

Bulletin No. 19 contains complete selection data for stock Diamond Couplings. Your copy sent on request.

DIAMOND CHAIN COMPANY, Inc.
Where High Quality is Traditional
Dept. 435. 402 Kentucky Ave.
Indianapolis 7, Indiana
Offices and Distributors in All Principal Cities

DIAMOND **ROLLER CHAINS**

Circle 534 on page 19



. . . with Westinghouse Oil-Tite control stations—1 to 16 units

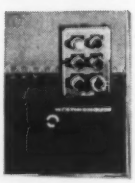
Interchangeable parts — stations, contact blocks, operators and indicating lights — right off the shelf, quickly give you a "tailor-made" Westinghouse Oil-Tite* control station to meet the requirements of any heavy-duty industrial equipment application.

Enclosures — die-cast and Bonderized — include cork-neoprene gasketing and close machine fits as positive seals against exposure to oil, coolants, cutting compounds, water and other foreign matter.

*Trade-Mark

New Pushbutton Guide

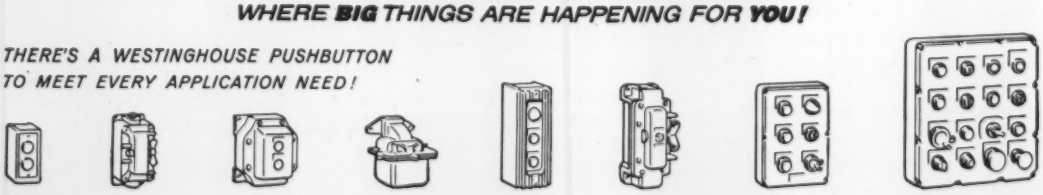
For more facts on why it will pay you to standardize with Westinghouse control stations, get a free copy of the new *Pushbutton Guide,* booklet B-6749. See your nearby Westinghouse salesman or write to Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-30210



WATCH WESTINGHOUSE!

*WHERE **BIG** THINGS ARE HAPPENING FOR **YOU**!*

THERE'S A WESTINGHOUSE PUSHBUTTON TO MEET EVERY APPLICATION NEED!



Use WELDED STEEL for Greater Strength with Less Weight!

The 50-ton weldment above is one of fifty-five identical Press Beds produced for one manufacturer of heavy presses. This piece, and the parts and assemblies illustrated at the left, are typical of thousands of Steel-Weld Fabricated units produced and machined by Mahon for manufacturers of processing machinery, machine tools, and other types of heavy mechanical equipment. Are you taking full advantage of the possibilities offered by welded steel components in your products? In the design of almost any type of heavy machinery there are pieces and sub-assemblies that can be produced more satisfactorily and more economically in welded steel —and with the additional advantages of less weight, greater rigidity and predictability. When you consider weldments, think of Mahon . . . because, you will find the Mahon organization a unique source for welded steel in any form . . . a source with complete facilities for design engineering, fabricating, machining and assembling . . . a source where design skill and advanced fabricating techniques are supplemented by craftsmanship which assures you a finer appearing product embodying every advantage of Steel-Weld Fabrication. See Sweet's Product Design File for information, or, better still, have a Mahon sales engineer call at your convenience.

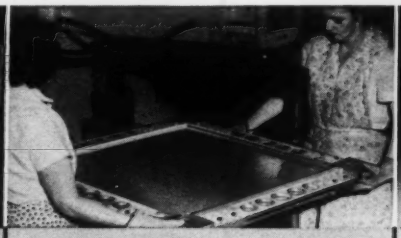
THE R. C. MAHON COMPANY • Detroit 34, Michigan

Sales-Engineering Offices in Detroit, New York and Chicago

Engineers and Fabricators of Steel in Any Form for Any Purpose

MAHON

Automatic welding of couplings to 6" aluminum pipe at 65% greater speed than hand welding. Couplings are welded to both ends at same time.



Spot welding angles to aluminum telephone booth top. 14 Sciaky machines in this department speed production of spot welded parts for diversified industries.

Automatic welding of .064 metal at rate of several feet per minute by inert-gas-shielded metal arc welding. Reynolds has available a wide variety of automatic welding equipment.

when you design aluminum parts requiring

WELDING

or

BRAZING

there is no substitute for REYNOLDS experience and facilities

You can design any welded aluminum parts for your products with confidence because Reynolds Aluminum Fabricating Service can produce these parts and produce them efficiently and economically to your specifications.

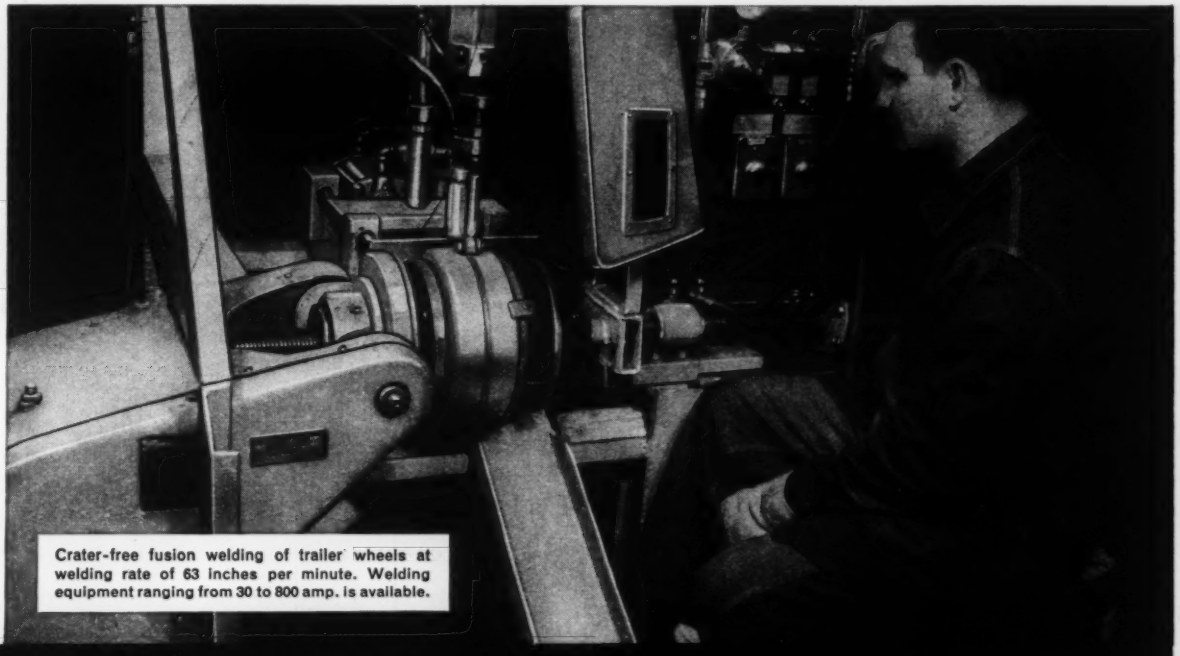
Reynolds years of day-in, day-out welding and brazing on a wide variety of jobs —plus continuous development in the use of welding and brazing equipment and techniques—assure you the very highest quality welded and brazed parts.

Reynolds offers a wide variety of welding and brazing equipment—you get the benefit of equipment exactly suited to your requirements. And Reynolds constant quality control minimizes "down time"—cuts your costs.

For full details on these and other services call the Reynolds Office listed under "Aluminum" in your classified telephone directory or write *Reynolds Aluminum Fabricating Service, 2061 South Ninth Street, Louisville 1, Kentucky.*

Watch for Reynolds new program, "Circus Boy"—Sundays on NBC—TV

REYNOLDS ALUMINUM FABRICATING SERVICE



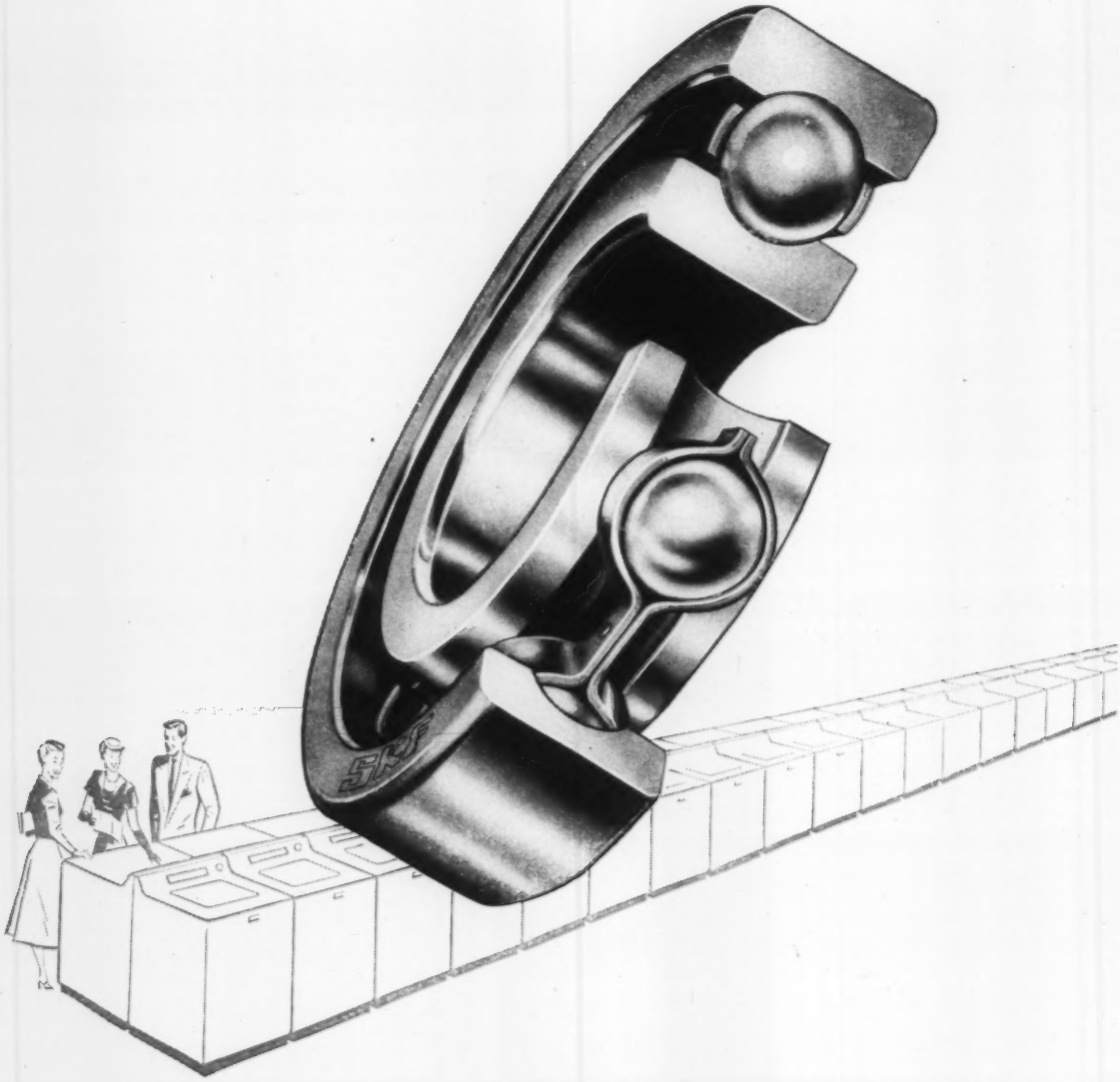
Crater-free fusion welding of trailer wheels at welding rate of 63 inches per minute. Welding equipment ranging from 30 to 800 amp. is available.

Brazing refrigerator parts. Continuous operation of automatic brazing equipment assures on schedule production of brazed parts.

The Finest Products Made with Aluminum are made with REYNOLDS ALUMINUM

Write for your free copy of Reynolds 24-page "Catalog of Facilities."

BLANKING • EMBOSSING • STAMPING • DRAWING • RIVETING
FORMING • ROLL SHAPING • TUBE BENDING • WELDING • BRAZING • FINISHING



Quiet, smooth, perfect performance...

in home laundry equipment using SKF® ball bearings

Leading manufacturers of home laundry equipment (names on request) rely on SKF Single Row, Deep Groove Ball Bearings for quiet, smooth-running performance.

Whatever your product, it will pay you, too, to switch to SKF anti-friction bearings and get the *plus values* which are built into every one. 7730

SKF—EVERY TYPE—EVERY USE

SKF

- *Ball Bearings*
- *Cylindrical Roller Bearings*
- *Spherical Roller Bearings*
- *Tapered Roller Bearings* (Timken®)

*Reg. U.S. Pat. Off. Tyson Bearing Corporation

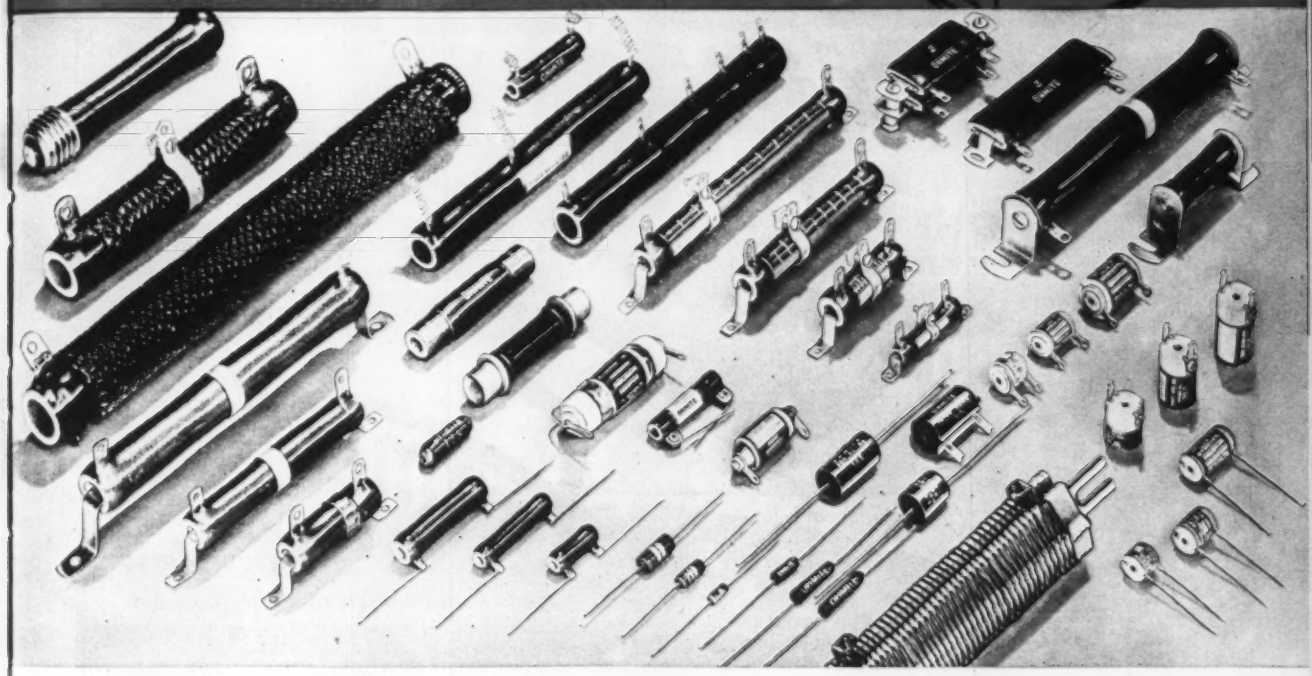
SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.

Circle 538 on page 19

OHMITE®

has exactly the resistor you need

Ohmite offers the most complete line of wire-wound resistors on the market . . . fixed, adjustable, tapped, non-inductive, and precision resistors in many sizes, types of terminals . . . in a wide range of wattages and resistances.



Industry's most complete line of wire-wound resistors!

The extensive range of Ohmite types and sizes makes possible an almost endless variety of Ohmite resistors to meet each individual need. Ohmite offers resistors in more than 60 sizes—ranging from 2½" diameter by 20" long to ¼" diameter by $\frac{9}{16}$" long—to meet your exact requirements. MANY SIZES ARE CARRIED IN STOCK. These rugged resistors have proved their quality under the toughest operating conditions. Ohmite application engineers will be pleased to help you in selecting the right resistors for your job.

Write on company letterhead for Catalog and Engineering Manual No. 40.

OHMITE MANUFACTURING COMPANY, 3618 Howard Street, Skokie, Illinois (Suburb of Chicago)

Be Right with **OHMITE®**

RHEOSTATS • RESISTORS • RELAYS • TAP SWITCHES

Circle 539 on page 19

CAMLOC FASTENING DEVICES

INSTALL FAST

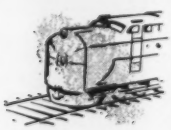
OPEN FAST

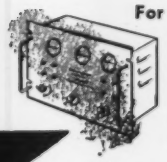
CLOSE FAST

HOLD FAST

"Fast" means a lot of things when you're talking about production line fabrication, equipment operation or maintenance and service. In every case "fast" means CAMLOC, because Camloc Fastening Devices are designed with all meanings in mind. They speed up maintenance and service of operating equipment by providing quicker accessibility to vital components . . . and they save manufacturing time and money by affecting production line economies during fabrication.

Camloc Fastening Devices not only install easily and quickly, but also permit greater tolerances between sheets; support heavy loads without binding. And they're designed to withstand severe shock and vibration (you'll find them on America's fastest aircraft; on access panels, doors, cowlings, electronic equipment).

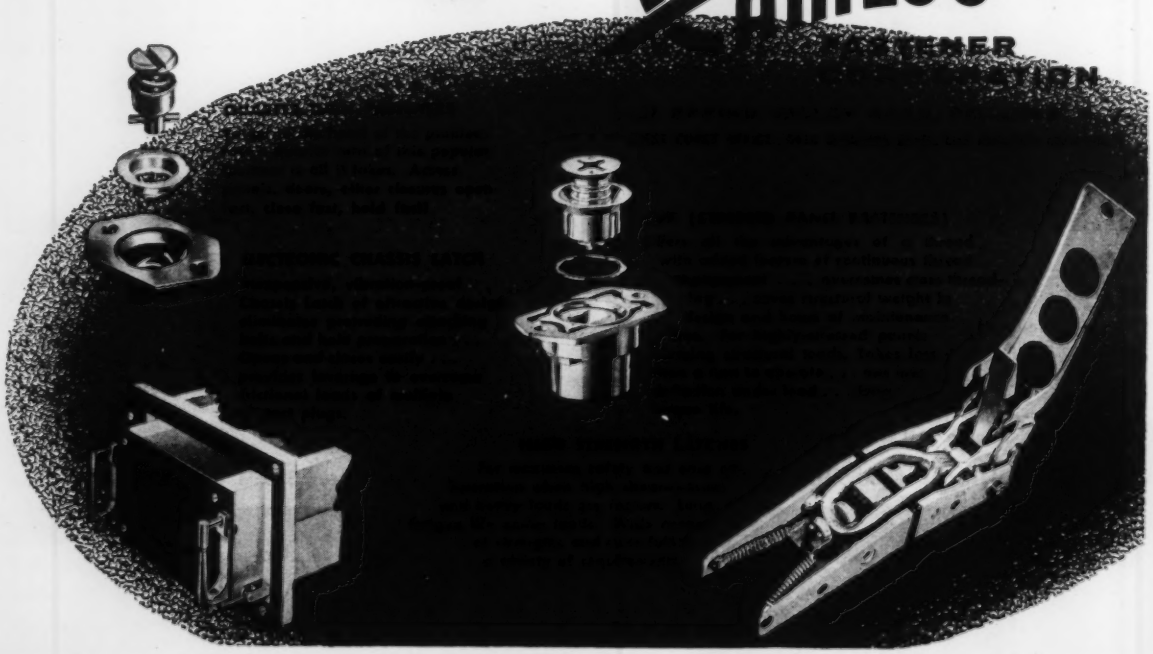




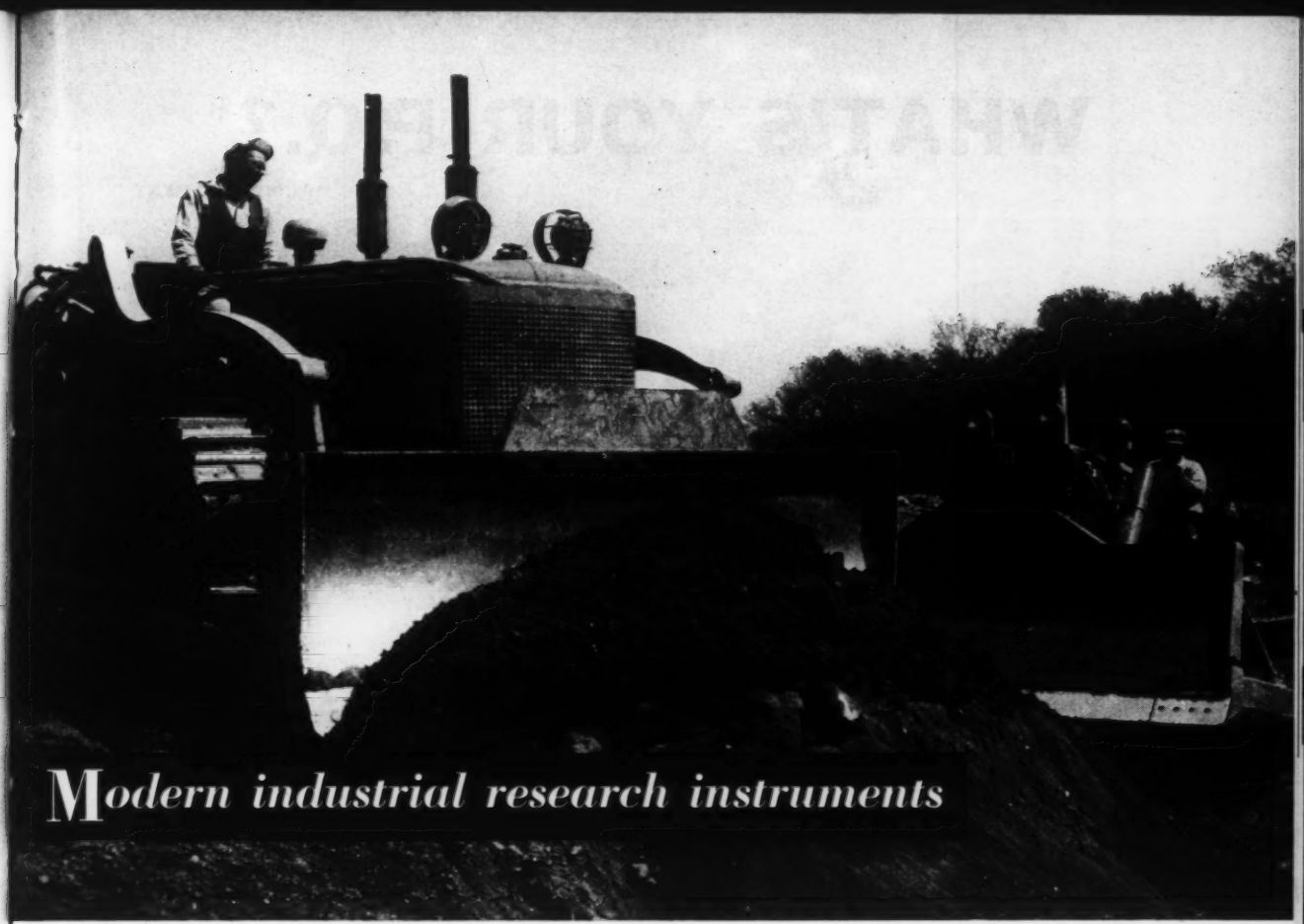
For fast fabrication, fast open-close action, fast holding . . . whatever "fast" means to you . . . it always means Camloc.

Complete catalog information on any of Camloc's fastener products is yours for the asking . . . just specify your interest.

CAMLOC



Circle 540 on page 19



Modern industrial research instruments

THESE seven-ton bulldozers are truly research tools, for they are taking part in an exhaustive program for the study and revision of accepted methods of oscillographic recording system design and manufacture.

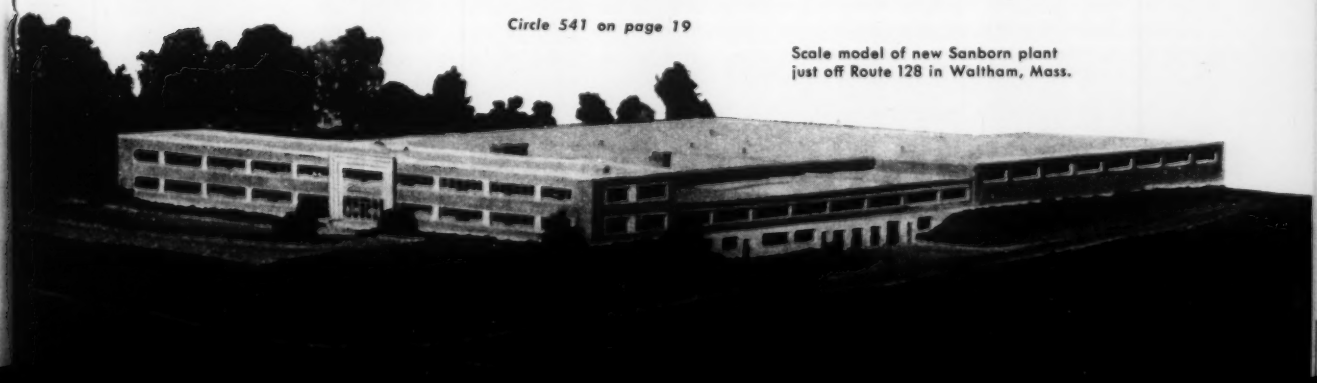
Yes, Sanborn Company is on the move! The instruments above are levelling off small mountains of earth and rock in preparation for a new and modern Sanborn plant near Boston, Mass.

Completion of the structure late this year will mean vastly improved facilities for research, manufacturing and other operations. This will directly and immediately benefit not only the work Sanborn does, but also the people who use Sanborn systems, amplifiers, recorders and other components. It will make possible more rapid development and production of new instruments, and increased opportunity for a larger number of people to apply their skills to the problems of modern instrument design and manufacture.

This represents not "just a new plant", but a reflection of Sanborn's growing role in providing better answers to industry's oscillographic recording needs.

Sanborn Company, Industrial Division, Cambridge 39, Massachusetts

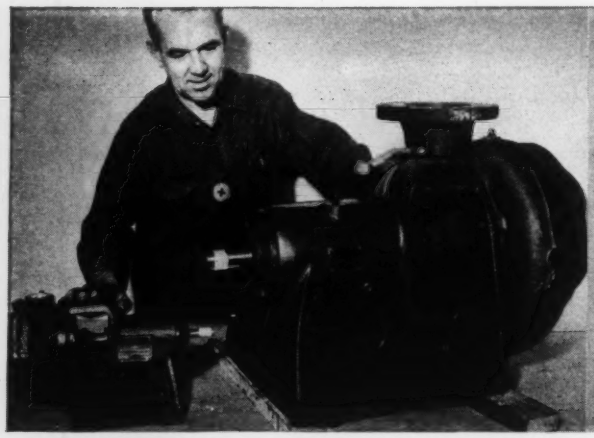
Circle 541 on page 19

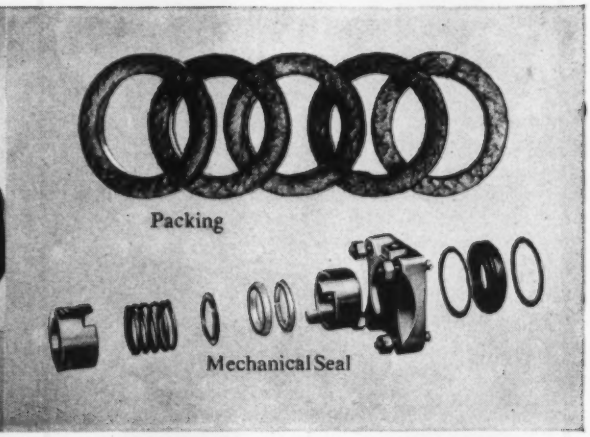


Scale model of new Sanborn plant just off Route 128 in Waltham, Mass.

WHAT'S YOUR P.Q.?*

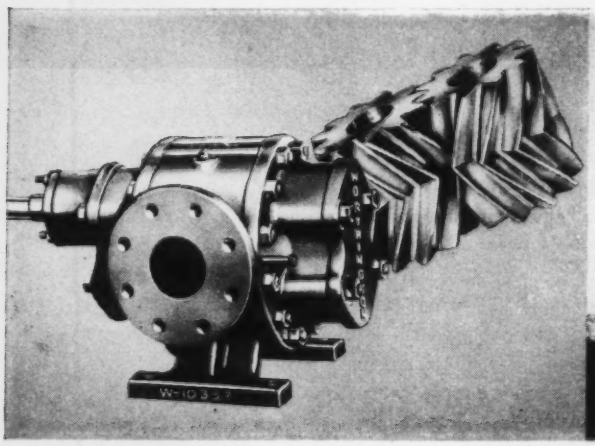
*PUMP QUOTIENT

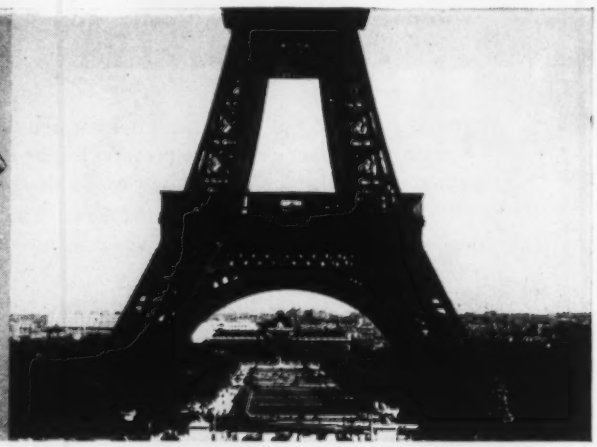




Pump standardization—how do you benefit? By standardizing, you can often drastically cut your spare parts inventory. With Worthington's SESC (Standard End Suction Centrifugal) line, you are also assured of immediate delivery from factory or distributor stocks. Because the SESC line consists of standardized "parts" not "pumps," it can be built in many different combinations . . . 70,480 to be exact. For all these reasons, more and more companies are turning to SESC pumps. See bulletin W-300-B4.

Packed stuffing box or mechanical seal—which is preferred? Each has its applications. Mechanical seals are gaining in popularity year after year. With Worthington's Standard End Suction Centrifugal pumps you not only get your choice of mechanical seals—or packing—but you can easily convert from one to the other using standard stock parts. This "interchangeability" is just one of the many extra advantages of Worthington's SESC line. For more details write for bulletins W-300-B4 and W-350-B16.

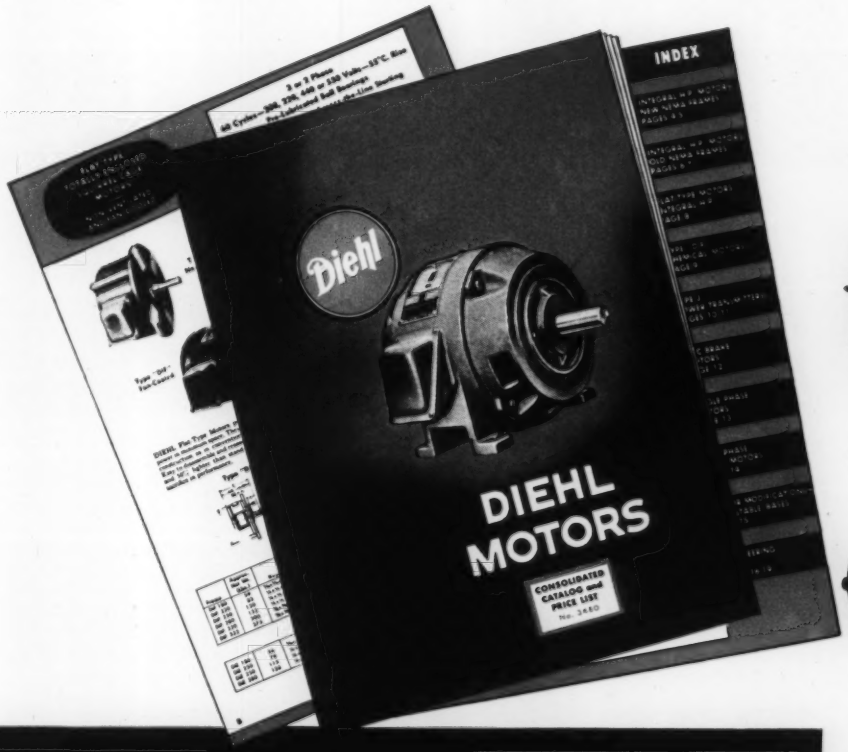




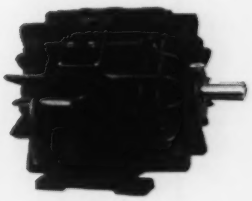
Which pump is best for difficult suction conditions? Worthington's close-clearance rotary pump is self-priming and can operate under vacuums as high as 28 inches of mercury. The large unobstructed suction opening in this herringbone gear pump permits operation with thin or viscous liquids at high efficiency. The double-helical gears balance all end thrust, eliminate trapping of liquid between gear teeth and provide a quiet, pulsation-free flow at high speeds. For the full story, ask for bulletin W-483-B2.

Whose pumps would you expect to find in the Eiffel Tower? If you said "Worthington's," your P.Q. is all right. The original steam-driven pumps that power the Eiffel Tower's 100-passenger hydraulic elevators were built by Worthington back in 1889. The most recent additions, modern electric-drive Worthington pumps, moved into the Tower just last year. Today as then, wherever men must move liquid, they turn to the company with a reputation for performance. Worthington Corp., Harrison, N. J. PC. 6.5

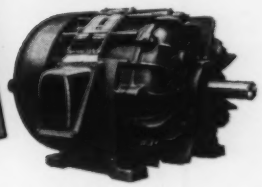
WORTHINGTON



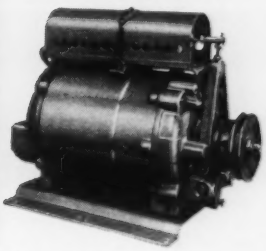
Type "DIE" Totally Enclosed Motors (Non-Ventilated)



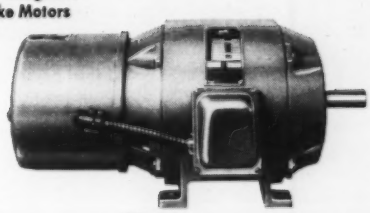
Type "DIF" Totally Enclosed Motors (Fan Cooled)



Type "J" Power Transmitters with solenoid



Type "DI" Magnetic Disc Brake Motors



Your new DIEHL motor catalog is ready!

. . . to show you this varied line of superior motors

Revised and up-to-date with new NEMA ratings and dimensions, this 20 page catalog is yours for the asking. It illustrates, describes and prices many different sizes and types of motors and contains much useful engineering data . . . all conveniently arranged for quick and easy reference. An excellent publication for desk use.

Diehl

DIEHL MANUFACTURING COMPANY

Electrical Division of THE SINGER MANUFACTURING COMPANY

Finderne Plant, SOMERVILLE, NEW JERSEY

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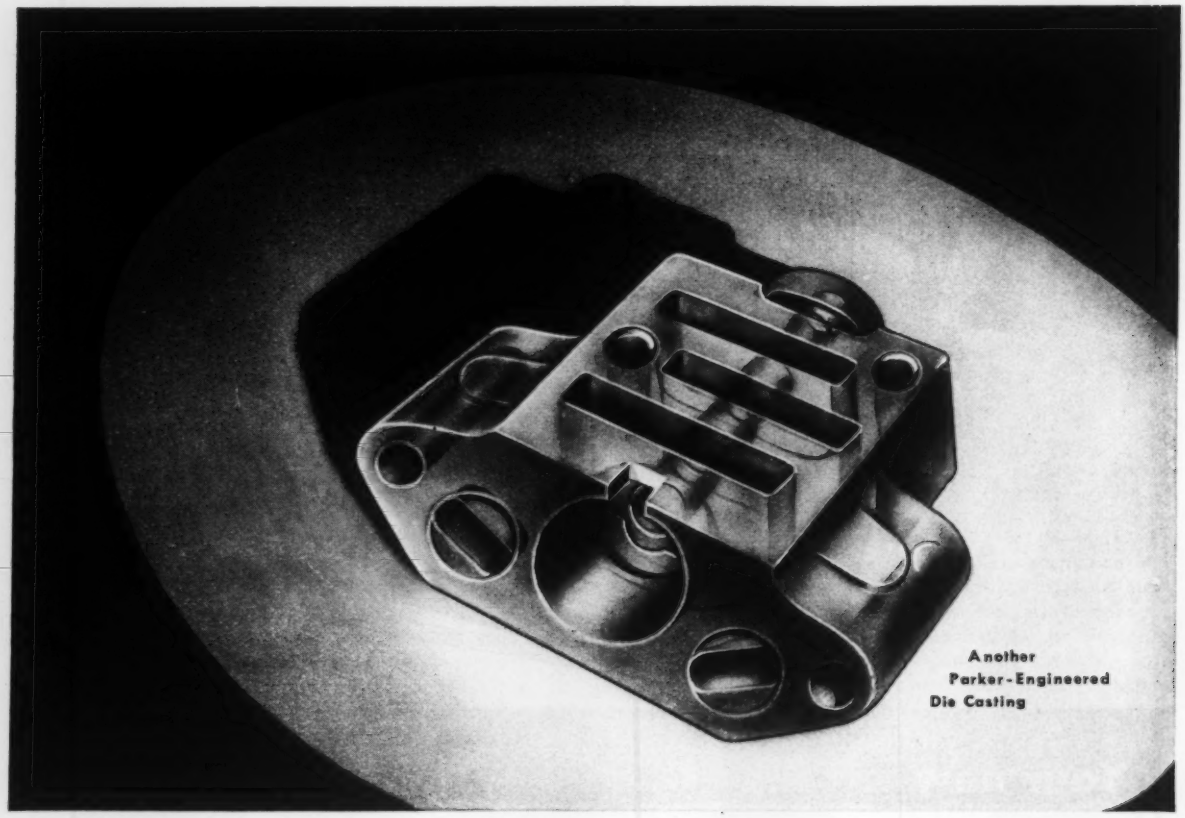

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Daniel F Marsh • 35 Chestnut Street

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Girard L. Palmer • Belden Hill Road

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Just imagine the savings effected by producing this intricate part *complete* . . . in *one casting operation.* Here, certainly, is dramatic proof of the skill, experience and creative imagination of Parker die designers. And when you add to these Parker-engineered cost savings other advantages such as high density, smooth as-cast finish and good tensiles, you can see why more and more design engineers are turning to Parker Die Castings for their component parts.

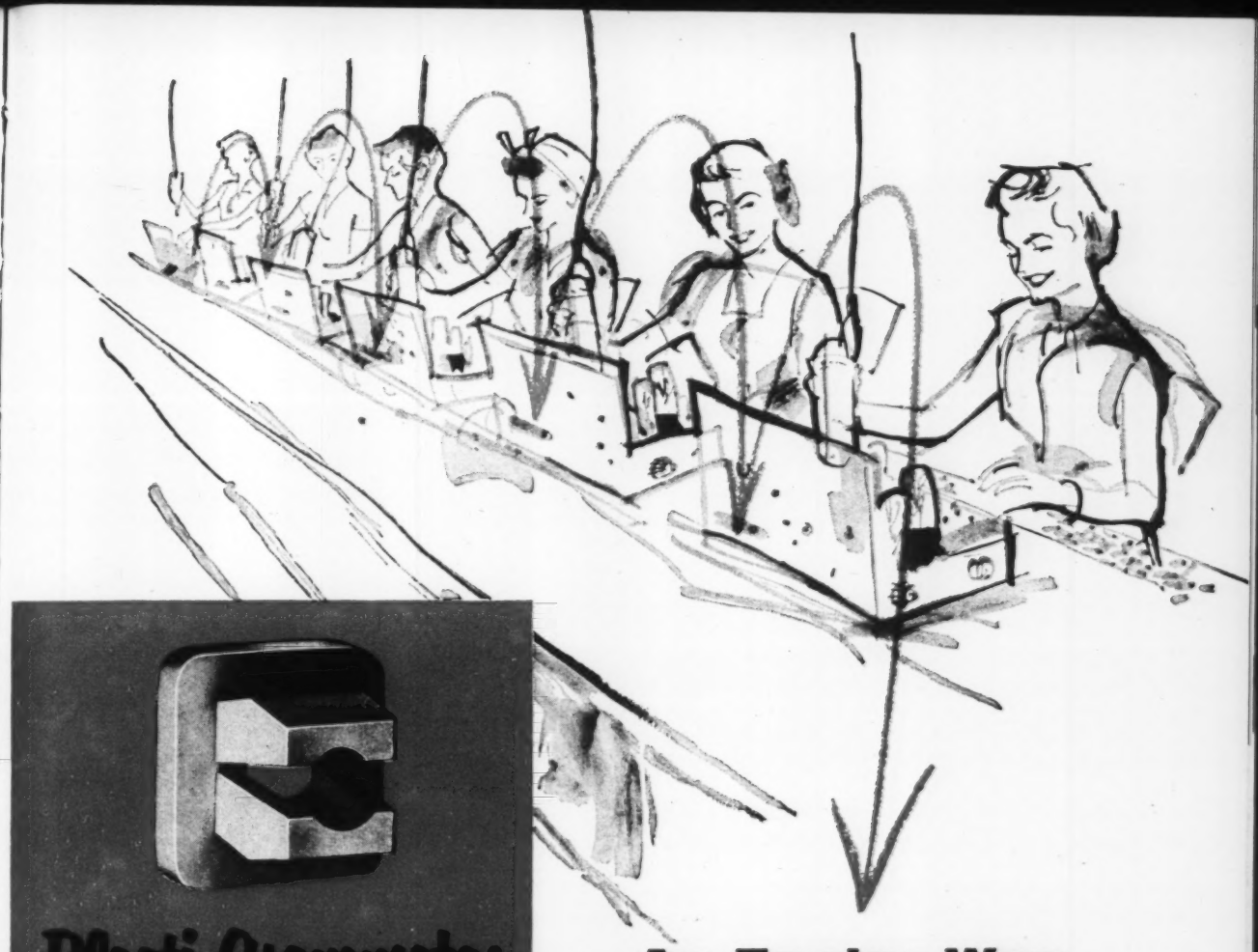
Parker has been a leader in die casting for 50 years—an old hand with new ideas. This skill and experience saves you money on *your* component parts. Just call the nearest Parker sales engineer or write the factory direct.

Parker White Metal Company • 2153 McKinley Ave., Erie, Pennsylvania

PARKER

high pressure ALUMINUM and ZINC die castings POWDERED METAL PARTS

Circle 544 on page 19

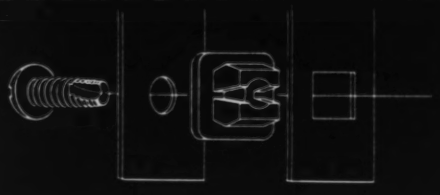


Plasti-Grommets®

Self-Retaining Blind Screw Receptacles

- non-corrosive
- non-conductive
- vibration-resistant
- does not chip or craze porcelain
- available in any color

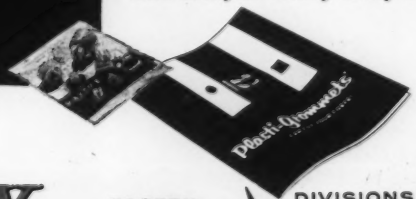
35 sizes stocked



. . An Easier Way to Speed Production

. . . and cut assembly costs, too! Plasti-Grommets snap into a prepared hole at the touch of a finger . . . replace other costly retained threaded receptacles, tapped holes or retained nuts. Locked in place by a thread-cutting screw, Plasti-Grommets provide a firm, durable, vibration-resistant fastener.

Developed at the Fastex creative engineering labs, Plasti-Grommets are a typical example of the simplification possible in multi-part assembly operations. Fastex volume production of metal and plastic components—on specialized manufacturing equipment—increases the economies gained through Fastex engineering ingenuity. These savings are being realized today in nearly every mass-production industry.



Test Plasti-Grommets® . . . *send for informative brochure and free packet of these remarkable nylon blind screw receptacles . . . actually test them . . . see how they can reduce your costs!*

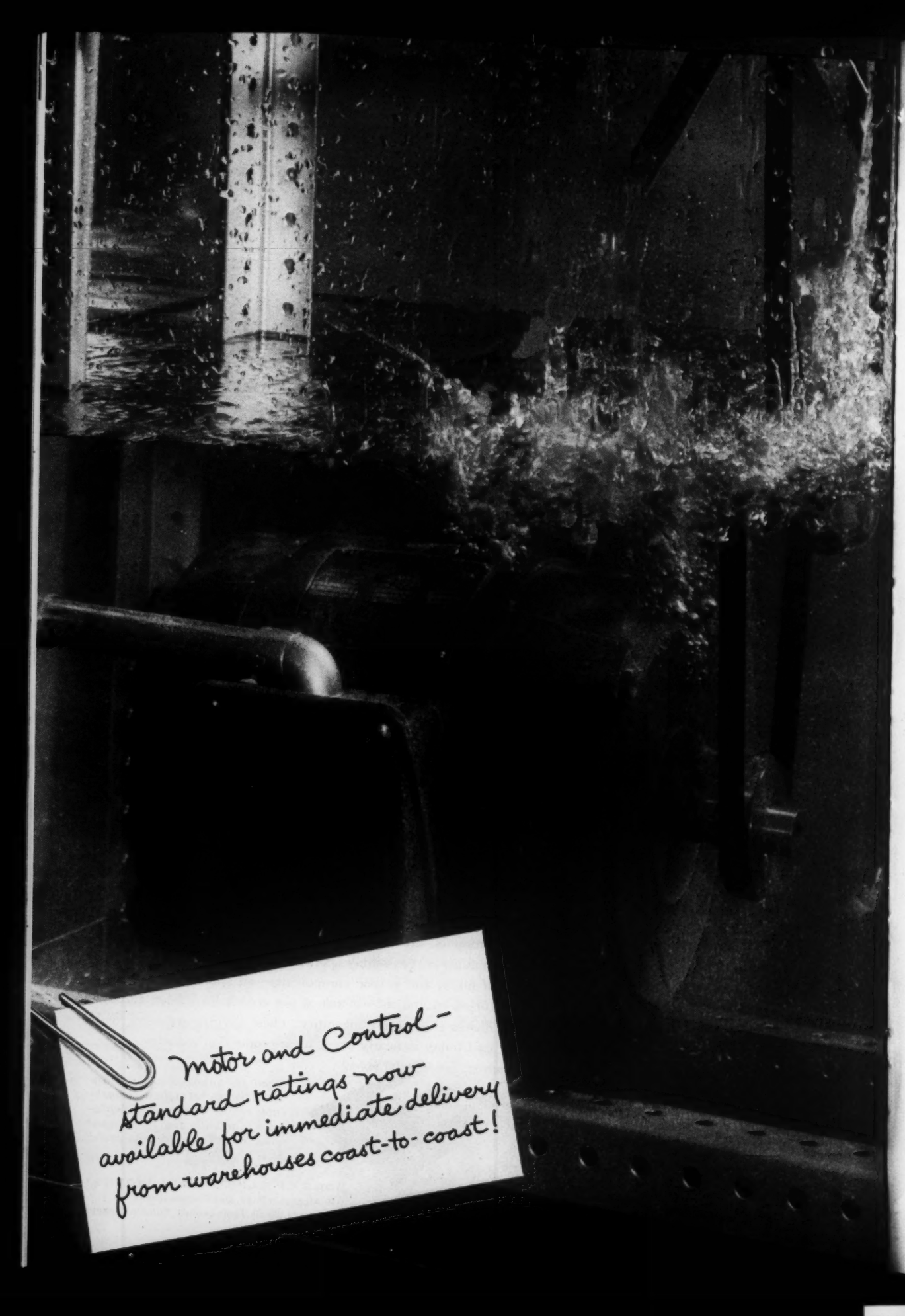
TRADE MARK

FASTEX

FASTEX
SHAKEPROOF

DIVISIONS OF ILLINOIS TOOL WORKS
195 Algonquin Road, Des Plaines, Illinois
In Canada: Canada Illinois Tools Limited, Toronto, Ontario

Circle 545 on page 19


Motor and Control—
standard ratings now
available for immediate delivery
from warehouses coast-to-coast!

TOMORROW:

A Standard Motor That Can Live With Water?

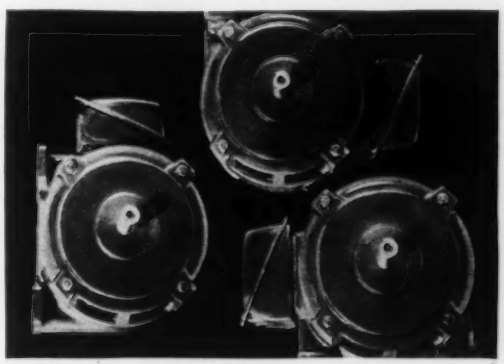
The New Life-Line A Is Another Step Closer

Today's standard motors cannot long endure the water conditions shown here. But Westinghouse is working toward a standard motor that can "live" with water like this tomorrow.

Meanwhile improved frame design, insulation and bearing protection give the Life-Line® "A" more protection than ever before. It can withstand more water and other contamination than any other motor you can buy. It's industry's closest approach to a standard motor that can operate with or within water—in any amount.

Your Westinghouse sales engineer can show you many additional reasons why the Life-Line "A" is industry's most advanced and preferred motor. Call him today.

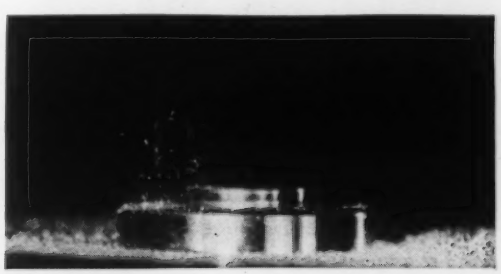
J-21924-A



New cast-iron frames and brackets utilize the finest grained castings with uniformly thick-walled sections precisely fitted and sealed—another reason why the Life-Line "A" is so preferred.

WATCH WESTINGHOUSE!

COVER THE PRESIDENTIAL CAMPAIGN ON CBS TV AND RADIO!

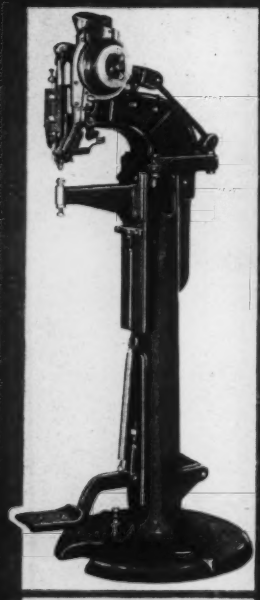


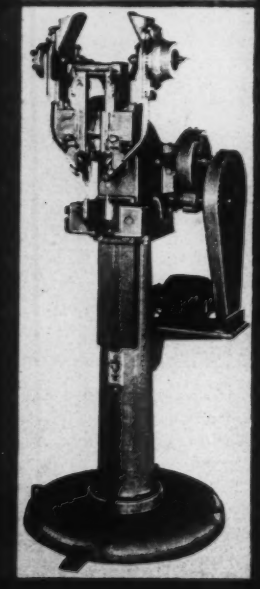
Two outer seals of new 4-way sealed bearing act as flingers and literally throw off damaging contaminations. Inner seals, attached to outer bearing race, are stationary and form a positive labyrinth.

Circle 546 on page 19

Production economy to match any other fastening method

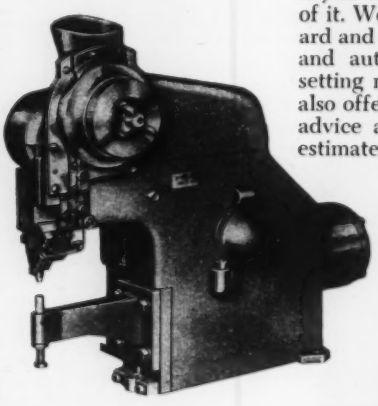
THOMSON RIVETS & RIVETING MACHINES





Riveting is an excellent method of joining things together. Moreover, rivets are usually cheaper than most fasteners. This means savings. Now consider that unskilled labor is fully competent to operate rivet-setting machines. Add these facts together, and you have real production economy.

THOMSON has specialized in the design and production of industrial rivets since 1885. That's a lot of know-how; you will do yourself a favor if you take advantage of it. We make standard and special rivets, and automatic rivet-setting machines. We also offer engineering advice and give free estimates.



Upper left: Floor type, foot-pedal operated.

Lower left: Floor type, motor operated.

Bottom right: Bench type, motor operated.

REPRESENTATIVES

Dolliver & Brother
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Gardner Screw Corp.
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Massachusetts

Shoe Factory Supplies Co.
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JUDSON L. THOMSON MFG. CO.
Waltham, Massachusetts

Circle 547 on page 19

satisfied customers keep coming back!

Here's a lady pleased pink with a new dishwasher . . . so enthusiastic a booster for someone's product she can hardly wait to tell about it, and a sure-fire prospect for future appliance needs. Chances are that a Packard Electric motor has a lot to do with her satisfaction, for Packard motors deliver quiet, dependable, long-lasting performance that's bound to please.

For more than 39 years, Packard Electric craftsmen have been building fractional horsepower motors that lead to one satisfied customer telling another. Packard builds a lot of satisfaction into every motor . . . and there's nothing better than a satisfied customer to boost both reputation and sales.

GM GENERAL MOTORS Packard

REG. U.S. PAT. OFF. TRADE MARK

Packard Electric Division
General Motors, Warren, Ohio

Circle 548 on page 19

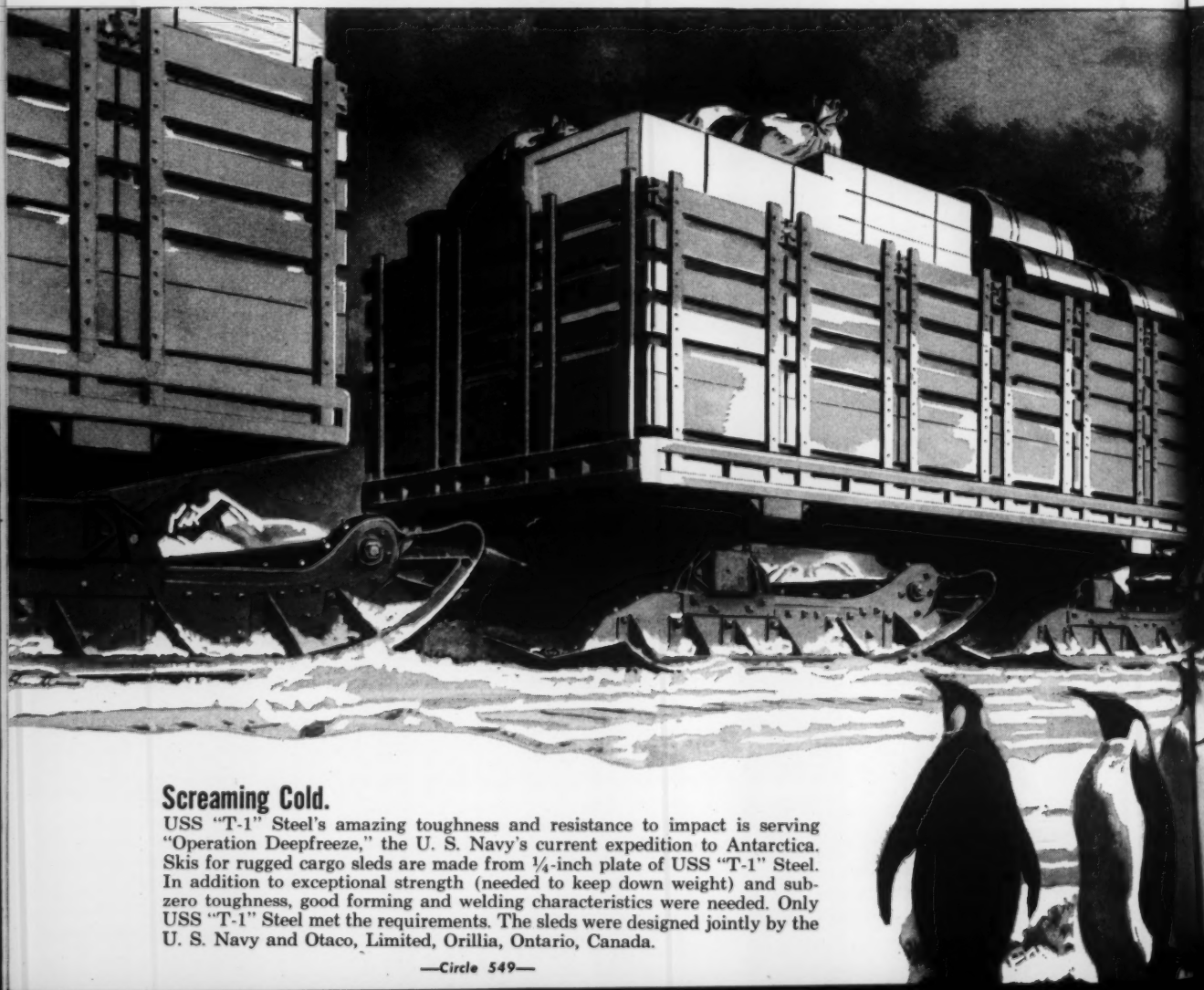
HOW USS "T-1" STEEL IMPROVES

Repair Reduces Downtime.

In this coal stripping operation, time costs more than any other item; and *lost* time, caused by breakage and wear of power shovel parts, was costing far too much. So the owner, Putnam & Greene, Inc., Philipsburg, Pennsylvania, started using USS "T-1" Steel for repair work. As a result, size and weight of parts have been reduced, while durability has been improved substantially. What's more, USS "T-1" Steel's good weldability speeds repair work.

28 Million Pounds of Wet, Abrasive Coal

are handled each day at this steam-electric generating station. And USS "T-1" Steel is being used at points of severe wear in coal chutes and hoppers, pulverizer feed pipes and exhaust pipes, and for liners of ash collectors. USS "T-1" Steel's durability under impact and impact abrasion, its great tensile strength and its good weldability are often essential in rugged coal handling equipment. USS "T-1" Steel can add service life and cut repair and maintenance costs.

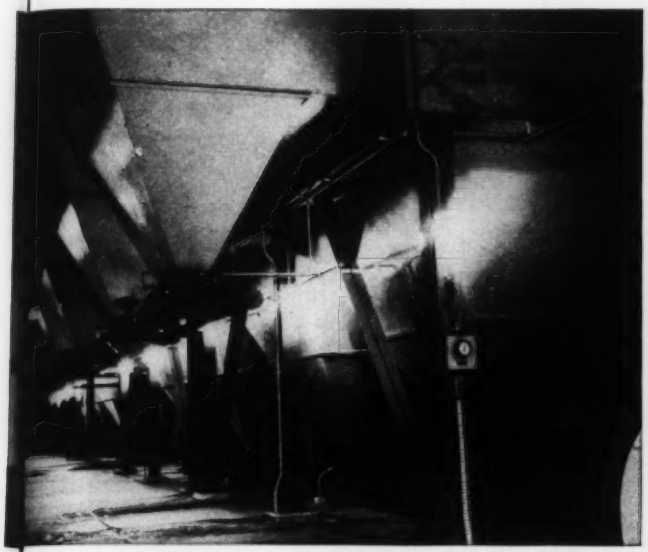


Screaming Cold.

USS "T-1" Steel's amazing toughness and resistance to impact is serving "Operation Deepfreeze," the U. S. Navy's current expedition to Antarctica. Skis for rugged cargo sleds are made from ¼-inch plate of USS "T-1" Steel. In addition to exceptional strength (needed to keep down weight) and subzero toughness, good forming and welding characteristics were needed. Only USS "T-1" Steel met the requirements. The sleds were designed jointly by the U. S. Navy and Otaco, Limited, Orillia, Ontario, Canada.

—Circle 549—

S THESE PRODUCTS:



Sizzling Hot.
By redesigning with USS "T-1" Steel, crane hooks for 250-ton ladles at U. S. Steel's Edgar Thomson Works were reduced in thickness from 8½ inches to 6 inches. The resulting weight saving of 3 tons permits an increase in actual crane capacity. The ladles, too, were redesigned with USS "T-1" Steel. All told, the weight saved adds 20 net tons to the capacity of each new ladle.

HOW IT CAN HELP YOU

USS "T-1" Steel, with its high minimum yield strength of 90,000 psi and its minimum tensile strength of 105,000 psi, can help you design or build lighter-weight equipment that will last longer. Its unusual toughness can help you design or build equipment capable of taking heavy impact and abuse at sub-zero temperatures. Its excellent weldability can help you cut the cost of fabricating highly stressed parts, and to reduce repair and maintenance expense. Its good creep rupture strength can help you put more durability in equipment that operates at temperatures as high as 900 degrees F.

Somewhere in your operation, versatile USS "T-1" Steel can help you. Write, wire, or phone United States Steel, Room 5424, Pittsburgh 30, Pa.

UNITED STATES STEEL CORPORATION, PITTSBURGH
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION
WAREHOUSE DISTRIBUTORS, COAST-TO-COAST
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

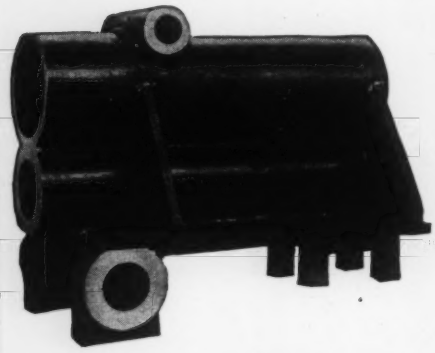
USS "T1" CONSTRUCTIONAL ALLOY STEEL

USS

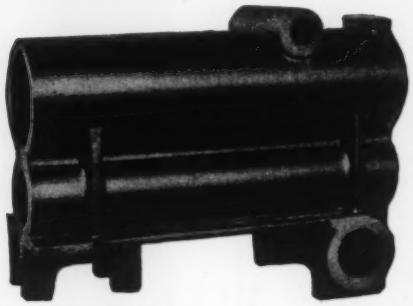
SEE The United States Steel Hour. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

UNITED STATES STEEL

Case History No. 35 • SPINDLE HOUSING



Welded $218.57



Gray Iron $109.67

Gray Iron Saves $108.90 Each
INCLUDING PATTERN COSTS!

This symbol assures you the most for your casting dollar

Here's why it pays to call in one of the more than 500 leading foundries displaying the Society symbol:

- The most recent technical and business information is available to each member through the Society to help you design better products at lower cost.
- The use of sound cost accounting procedures is recommended and encouraged among Society member foundries, assuring full value for your casting dollar.
- Improved castings result from the advanced techniques and the high sense of responsibility of Society members.

MAKE IT BETTER WITH GRAY IRON

Ultimate savings on this unit are even higher now that pattern costs are amortized.

Gray Iron castings successfully withstand the severe operational stresses to which this housing is subjected. Also, modern foundry techniques make possible the maintenance of the close tolerances required in this component.

This example of Gray Iron's ability to reduce costs and meet special strength and design requirements is not unusual. Chances are that you will find opportunities in your own products for similar savings with Gray Iron . . . applications where Gray Iron's unique advantages will also contribute to product improvement.

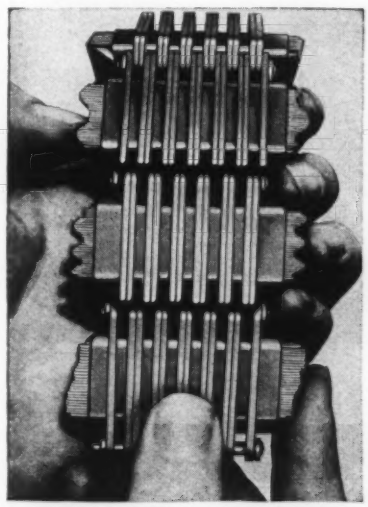
For specific technical or business information about Gray Iron, write direct to Gray Iron Founders' Society, Inc., National City—East 6th Building, Cleveland 14, Ohio.

GRAY IRON FOUNDERS' SOCIETY

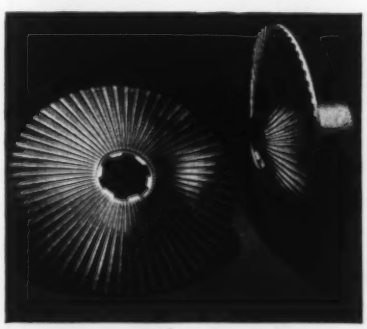
Circle 550 on page 19

For instant, accurate selection of rpm
...depend on LINK-BELT P.I.V.
--the only chain-driven variable speed control

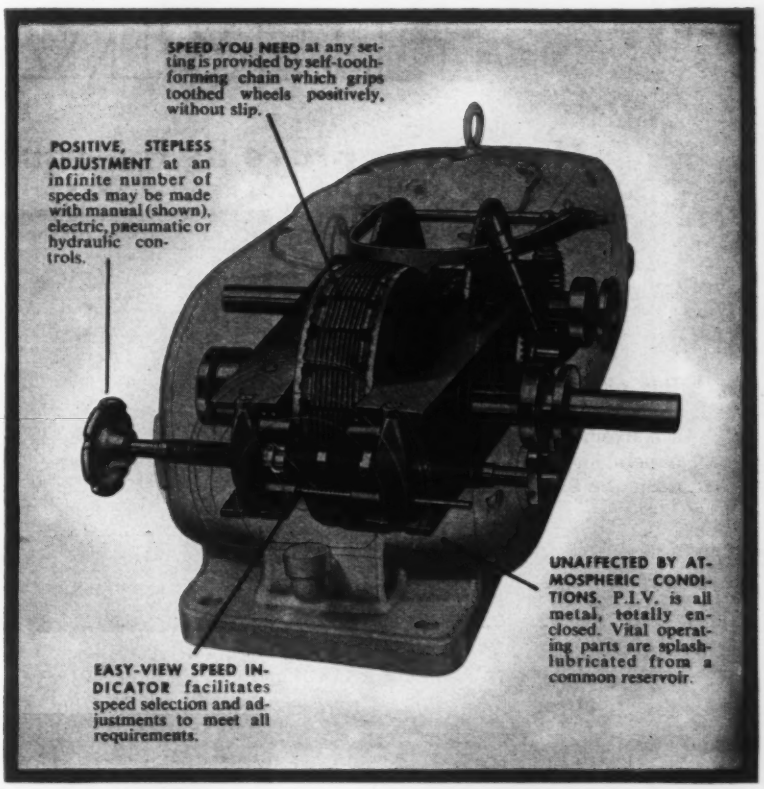
THOUGH departing considerably from conventional variable speed drive design, Link-Belt P.I.V. for over 25 years has enjoyed a reputation as the most reliable device of its kind. Engineers will appreciate the ingenuity of its exclusive drive principle . . . and even more, the flexibility and adaptability it offers.



SELF-TOOTH-FORMING CHAIN. Consists of a series of overlapping steel links containing packs of steel slats. These are free to move transversely, singly or collectively, serving as teeth. This easy, sliding slat movement assures positive action over the full range of operating wheel diameters. Slippage—which would cause fluctuations or steps in speed—is eliminated.



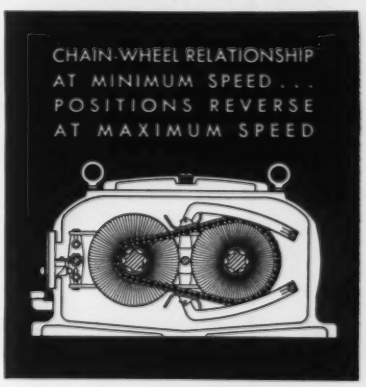
RADIALLY GROOVED WHEELS. Teeth are cut at a constant depth, their width increasing toward the periphery. Beveled sides of teeth provide gripping areas for slats during engagement . . . assure full, positive mesh.


SPEED YOU NEED at any setting is provided by self-tooth-forming chain which grips toothed wheels positively, without slip.
POSITIVE, STEPLESS ADJUSTMENT at an infinite number of speeds may be made with manual (shown), electric, pneumatic or hydraulic controls.
UNAFFECTED BY ATMOSPHERIC CONDITIONS. P.I.V. is all metal, totally enclosed. Vital operating parts are splash-lubricated from a common reservoir.
EASY-VIEW SPEED INDICATOR facilitates speed selection and adjustments to meet all requirements.

LINK-BELT P.I.V. is one infinitely variable speed drive not dependent on friction for transmitting power. Movement of its single control screw simultaneously varies effective diameters of the wheels on input and output shafts, making possible an infinite number of stepless speed adjustments between maximum and minimum settings—even while operating under full load.

Varying in capacity from ½ to 25 hp, Link-Belt P.I.V. drives are available in 8 different sizes and 16 standard types for horizontal and vertical mounting. Their compactness simplifies installation as a built-in part of the driven machine. In addition, even greater application flexibility can be achieved by making both motor and helical gear sets integral parts of the drive. All assemblies are totally enclosed, all operating parts automatically splash-lubricated.

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.



13,988

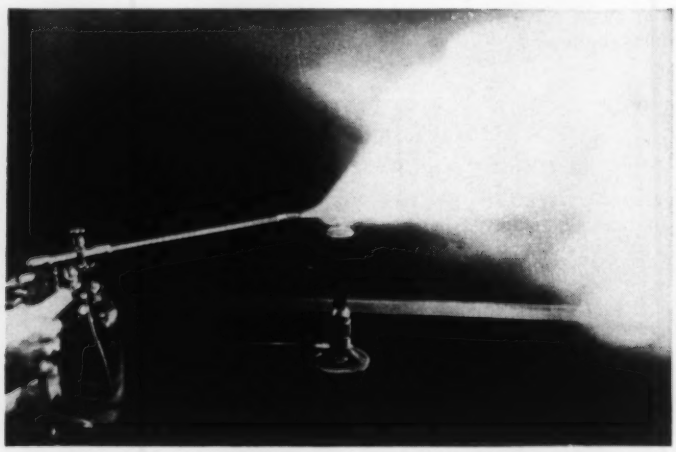
BOOK 2274 has 88 pages of complete facts and selection data on P.I.V.—will show how positive, infinitely variable speed selection can improve your designs. Ask your nearest Link-Belt office for a copy, or write direct.

Circle 551 on page 19

Announcing...the First

HYDRAULIC

Flame tests prove its fire-snuffing ability



This photo shows the instant combustion taking place when a conventional hydraulic oil of mineral oil type is atomized over a Bunsen burner.

In this photo, Shell Irus Fluid 902 replaces the mineral oil. Note that there is no ignition.

SHELL IRUS FLUID 902

Oil-Base fire-resistant FLUID

SHELL IRUS FLUID 902

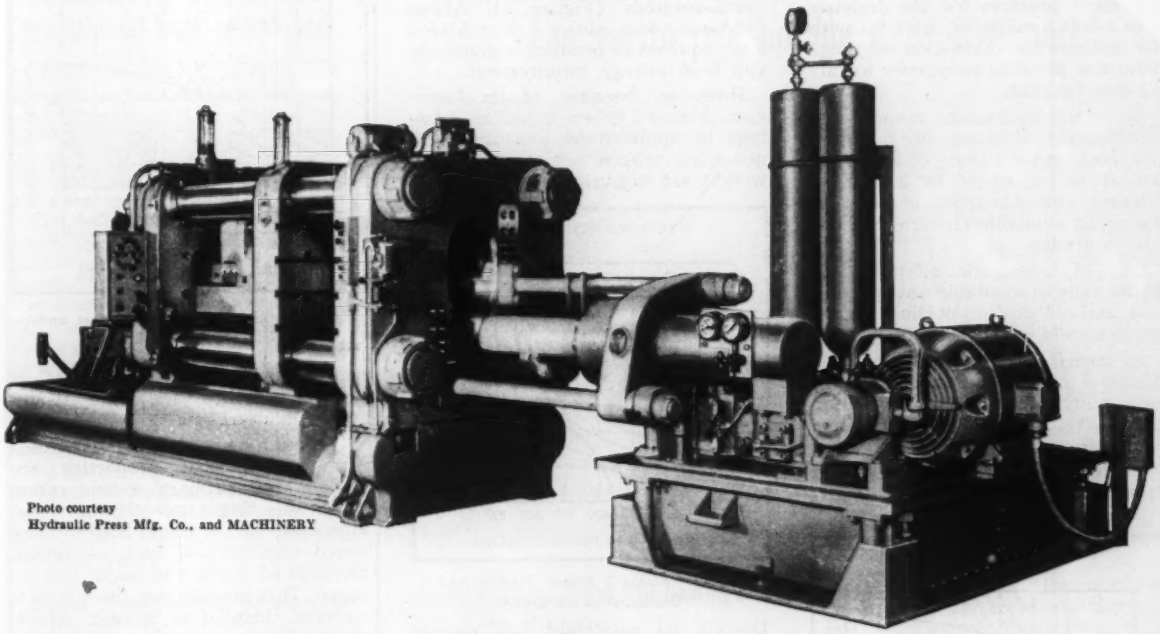


Photo courtesy
Hydraulic Press Mfg. Co., and MACHINERY

AFTER THREE YEARS of intensive research, field application and evaluation, Shell Irus Fluid 902 is now commercially available for use in industrial hydraulic systems. While its cost is far lower than other fire-resistant fluids, its performance is comparable.

No major modification of equipment is necessary. Shell Irus Fluid 902 is a special formulation containing no corrosive ingredients... no adverse effect on seals or fittings. It is a direct replacement for hydraulic oils now in service.

Noncorrosive, and nonrusting. Steel and copper panels immersed in Irus Fluid 902 for one week at 160°F have shown no significant signs of corrosion. Rusting has not been a problem in long-continued field tests.

This is an efficient fire-snuffing hydraulic fluid that can be widely used. Send coupon for details.

SHELL OIL COMPANY

50 WEST 50 STREET, NEW YORK 20, NEW YORK

100 BUSH STREET, SAN FRANCISCO 6, CALIFORNIA

SHELL

SHELL OIL COMPANY
50 West 50th St. or 100 Bush St.
New York 20, N. Y. San Francisco 6, Cal.

Please send me test data and information on Shell Irus Fluid 902.

Name_____

Company_____

Address_____

Circle 552 on page 19

(Advertisement)

New trends and developments in designing electrical products . . .

How to determine which General Electric Alnico Permanent Magnet grade offers the optimum set of magnetic and physical properties for a particular application

THE BASIC function of a permanent magnet is to provide a specific magnetic flux across a given air gap. The basic problem for the designer is to select a magnetic material with the optimum combination of magnetic and physical properties to fulfill this function.

Since the permanent magnet has considerable influence on the final size, cost, and efficiency of the product, it is important to know the primary characteristics of each of the seven available General Electric Alnico grades.

Each of these grades offers specific advantages in available energy, unit cost, and physical properties. No one grade excels in all of them.

In terms of energy product, cast Alnico 5 has no peer among magnetic alloys. Its 5 million minimum gauss-oersteds is 43% higher than Alnico 6.

Its demagnetization curve (Figure 1) shows that Alnico 5 has the highest residual induction of all the Alnicos, as well as relatively high coercive force. This means that a smaller cross-sectional area and less total volume will be required to maintain a given air gap density.

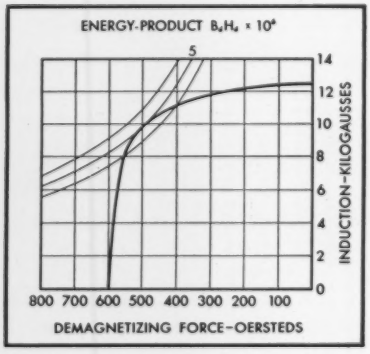


Fig. 1 — Alnico 5 Energy Product and Demagnetization Curves

Thus, where there are space restrictions, as in hearing aids, Alnico 5 has more available energy per unit volume. Where there are weight restrictions, as in airborne magnetrons, Alnico 5 offers more available energy per pound. And where there are cost considerations, as in loud speakers, Alnico 5 provides maximum external energy per dollar.

At the opposite extreme, Alnico 3 has one of the lowest energy products of the Alnicos — 1.38 million gauss-oersteds (Figure 2). About 3½ times more Alnico 3 than Alnico 5 is required to produce a given air gap field energy requirement.

However, because of its lower cost, Alnico 3 offers important savings in applications like toys and novelties, where performance and weight are not critical factors.

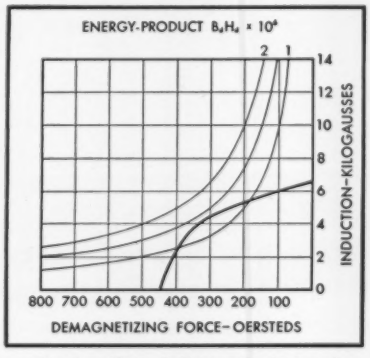


Fig. 2 — Alnico 3 Energy Product and Demagnetization Curves

Despite its relatively low energy product, Alnico 3 still provides more external energy, at lower cost, than does 37% cobalt steel — the best of all the magnet steels.

G-E Alnico 6 has an energy product of 3.5 million gauss-oersteds, ranking second only to Alnico 5. But the primary advantage of this grade lies in its flatter, more stable demagnetization curve (Figure 3, see top of next column).

Alnico 6 has ability to provide useful field energy under dynamic operating conditions. And in certain applications, Alnico 6, despite its lower energy product, will produce a higher gap flux density than Alnico 5.

For motors, generators and lifting applications, where the magnet is operating under varying demagnetizing influences, Alnico 6 offers greater stability and high useful recoil energy.

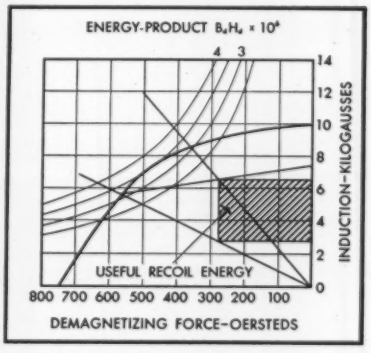


Fig. 3 — Alnico 6 Energy Product and Demagnetization Curves

Generally speaking, permanent magnets' physical properties are seldom the primary consideration when selecting magnetic materials. However, in certain high rotary speed applications, such as rotors, physical strength is of major importance. This necessitates the use of a sintered, instead of a cast, Alnico grade. These sintered magnets have tremendously improved physical properties, with but a slight sacrifice in magnetic properties.

Sintered Alnico 2, for example, has more than 20 times the tensile strength of cast Alnico 2. And, it has 10 times the transverse rupture strength, in addition to more uniform magnetic properties. Approximately the same order of structural improvements holds true for sintered Alnicos 4 and 5.

Selecting the proper magnetic material is a crucial and complex part of the design problem. For the assistance of a G-E Magnet Engineer in this, or any other, stage of your permanent magnet design, write: *Metallurgical Products Department of General Electric Company, 11126 E. 8 Mile Street, Detroit 32, Michigan.*

Progress Is Our Most Important Product

GENERAL ELECTRIC

Circle 553 on page 19

DU PONT ELASTOMERS

NEOPRENE · HYPALON

in Design

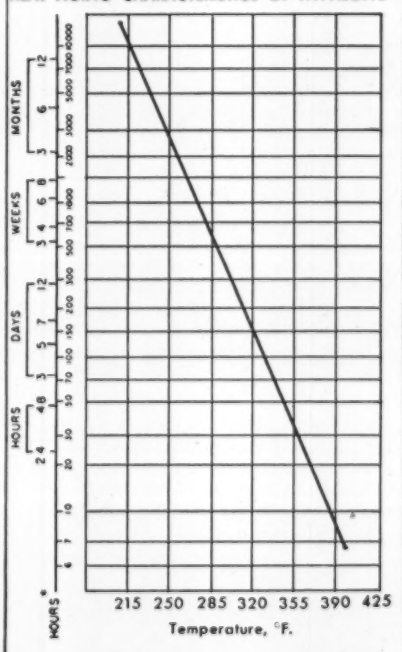
HYPALON® products have exceptional heat resistance

Compared to other kinds of rubber, HYPALON shows unusual resistance to hardening at elevated temperatures (250°-350°F.). This means an extra-long service life for HYPALON belts, hose, gaskets and other products which are used where heat is a problem.

The graph below is indicative of HYPALON's heat-aging characteristics. It shows, for example, that HYPALON compounds will retain 100% elongation after three weeks' *continuous* exposure at 285°F., three months at 250°F. and almost a year at 212°F. Longer service life naturally can be expected where temperatures are intermittent, or where air cannot get at the product—in a gasket, for example.

Other advantages of HYPALON include outstanding resistance to weather and oxidizing chemicals, *complete* resistance to ozone and the ability to be compounded in a wide range of light-fast colors.

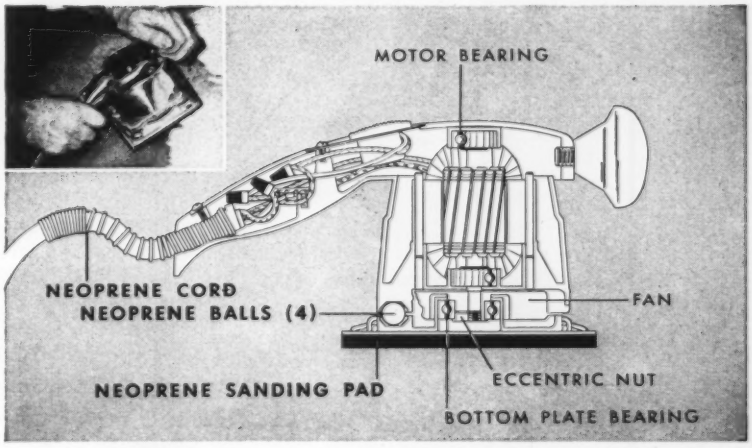
HEAT AGING CHARACTERISTICS OF HYPALON®



*Exposure time in which elongation dropped to 100%.

—Circle 554—

Over 200,000 sanders in service—and manufacturer has yet to replace one NEOPRENE part



Low-cost neoprene ball bearings last life of sander . . . resist abrasion, solvents

Since 1950, a manufacturer of sanders has sold 200,000 units—each with a neoprene sanding disk and a system of neoprene ball bearings. Not one of these neoprene parts has required replacement in that time.

Ingenious use of neoprene

The sander's design is shown above. An eccentric nut attached to the motor shaft imparts a circular motion to the plate that holds the sanding pad. Between this plate and the motor housing are four ½" neoprene balls—one at each corner and each confined in a cavity of 19/32".

These neoprene balls transmit vertical force from the sander to the surface being sanded. They also act as roller bearings as the sander revolves. Finally, thanks to neoprene's resilience, they serve as shock absorbers—minimizing noise and vibration.

Neoprene beats competitors

The manufacturer tested many materials for the balls. Steel balls were noisy and wore out quickly. Natural-rubber balls deteriorated within three weeks when exposed to paint solvents in wet sanding. In the same tests, however, neoprene resisted abrasion and solvents for nearly a year.

Basing his judgment on these tests, the manufacturer chose neoprene not only for the bearing balls but also for the pad to which the abrasive paper is attached. And as a further improvement, neoprene-jacketed cord was also adopted.

DU PONT
REG. U.S. PAT. OFF.

HYPALON *is a registered trademark of E. I. du Pont de Nemours & Co. (Inc.)*

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

Please send further literature and add my name to the mailing list for your free publications, the "Neoprene Notebook" and "Facts about HYPALON®," which show how the Du Pont elastomers are used in designing new products, improving old.

E. I. du Pont de Nemours & Co. (Inc.)
Elastomers Division, Dept. MD-8
Wilmington 98, Delaware

Name _____ **Position** _____

Firm _____

Address _____

City _____ **State** _____

THE

A B C

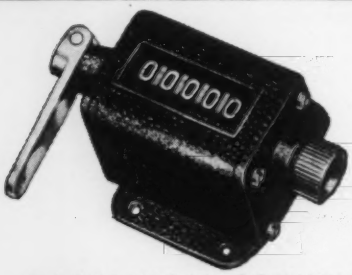
OF

1 2 3

Why is COUNTROL

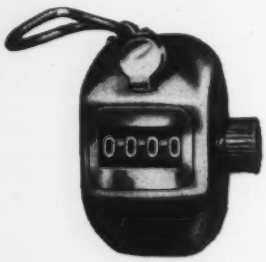
important in every business today?

Countless times a day, every business needs to know "how many? . . . how much? . . . how far? . . ." and many other questions that can be answered only by facts-in-figures. But how to get these figures . . . from so many different machines, processes, operations and systems? Veeder-Root Counters are doing it every day, by means of:



MECHANICAL COUNTING

Small Resets count strokes, turns, or pieces . . . are used by thousands for moderate duty in parts inspection, quality control, conveyors, machine tools, light presses, etc.



HAND COUNTING

Where objects or units cannot be counted electrically or mechanically, hand-operated counters like this Hand Tally do the job. For instance, quick spot checks of production or performance, traffic count, inventory, etc. Fits palm of hand, counts one for each pressure of thumb lever, resets to zero by turning knob.

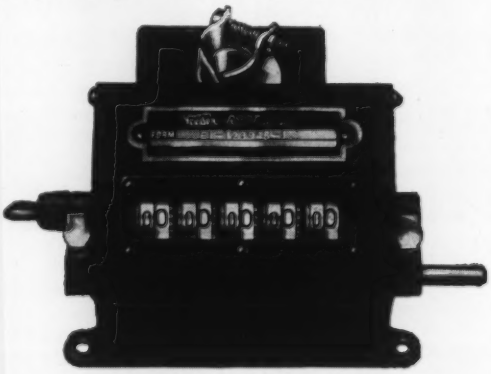
Insist on Standard

VEEDER-ROOT COUNTERS

from your Industrial Supply Distributor

ELECTRICAL COUNTING

These remote-indicating counters bring your production machines as close as your office wall. AC or DC, they can be connected in series with any simple switch, and will transmit production figures *instantly* over any distance. May be panel-mounted in groups.



CONTROLLING

Set it for the exact number of turns, pieces, or operations required . . . and this Predetermining Counter will control the run *exactly* . . . preventing over-runs and shortages. When the predetermined number is reached, counter will light a light, ring a bell, or actuate a stop-motion.

IN SUM: *If it can be counted or controlled . . . count on Veeder-Root to do it. Get in touch with your Industrial Supply Distributor for standard counters for application to your production machines and processes. And get in touch with Veeder-Root for counters to be built into original equipment.* **Veeder-Root Inc., Hartford 2, Connecticut.**

FINGERS OF STRENGTH

FINGRIP

—the strip terminal with greater gripping power

Get stronger, more uniform and faster low-cost wire terminations with the new Burndy FINGRIP. Unlike ordinary terminals of this type, FINGRIP, with strong, gripping finger-like construction, gives not two, but *four* individual gripping actions with the pressure evenly distributed over the large contact area.

A dimpled catch in the rugged, solid back of the FINGRIP provides a ratchet, locking action which maintains a consistently uniform pull-out value — even after the connection has been made and broken many times. Stronger, better conductivity joints are assured by double snubbing action of the exclusive wave-type indents.

- *Finger-like grip — grips stronger.*
- *Pressure distributed over 5 points.*
- *Ratchet catch increases gripping power.*
- *Double snubbing action of wave-type indents assures high pull-out strength for solid or for stranded conductors.*
- *Insulation grip accommodates all types of insulation.*

speed and uniformity

Installation presses for FINGRIP terminals operate as swiftly as stripped wire ends can be fed. Insertion of the wire automatically actuates the press . . . no levers, no pedals are needed. This speed plus the structural method of maintaining pull-out values offers new production advantages and economies.

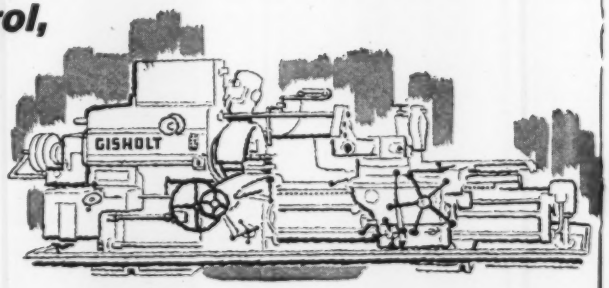
BURNDY 56-13R

NORWALK, CONNECT. • TORONTO, CANADA • OTHER FACTORIES: NEW YORK, CALIF., TORONTO • EXPORT: PHILIPS EXPORT CORP.

Circle 556 on page 19

HOW WARNER-EQUIPPED MACHINE DRIVES BOOST PRODUCTION AND CONTROL COSTS!

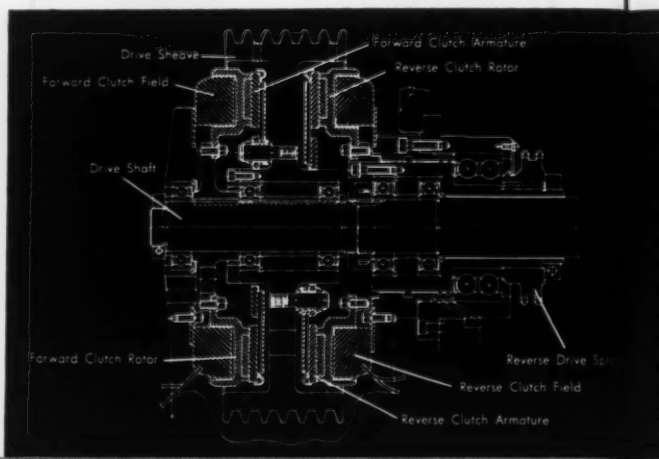
Electric Clutches improve control, save motor maintenance on Gisholt turret lathe!



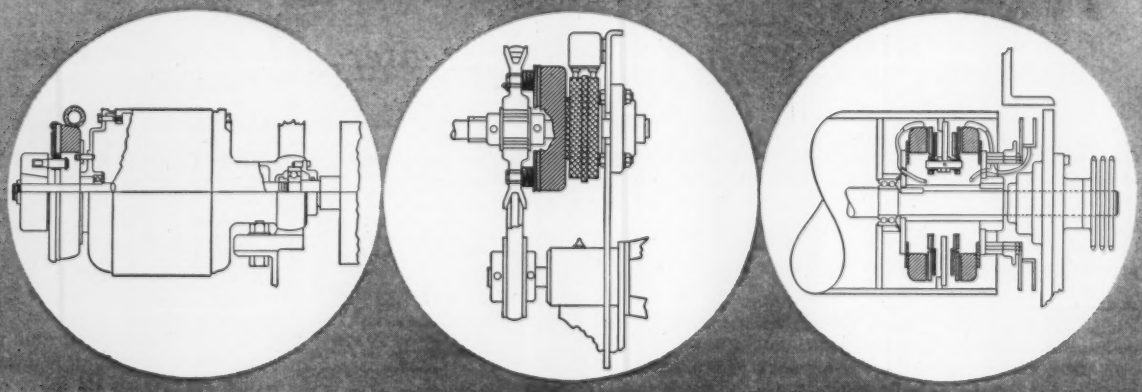
Here's a unique and extremely simple design—one constant running drive motor belted to a constant speed drive sheave, and two Warner Stationary-Field Electric Clutches accomplish all functions of starting, stopping, reversing, and jogging the spindle of this Gisholt Turret Lathe. Benefits to Gisholt users are many, including simpler control of actuating elements . . . precise inching control of the chuck . . . fast reversing . . . and reduced loading on the drive motor.

Get the jump on competition by doing as hundreds of America's leading equipment builders are doing today . . . using Warner "RF" Electric Brakes and "SF" Electric Clutches to increase machine performance and facilitate automatic control. With simple magnetic circuits . . . thicker and tougher friction surfaces and more compact design . . . these new Warner units give you all the revolutionary control advantages made possible by electro-magnetic actuation . . . plus more of the dependable, trouble-free operating features your customers want to increase their production and control their costs.

Now in production and ready for delivery to you . . . capacities, 125 to 700 lb ft, maximum static torque ratings.



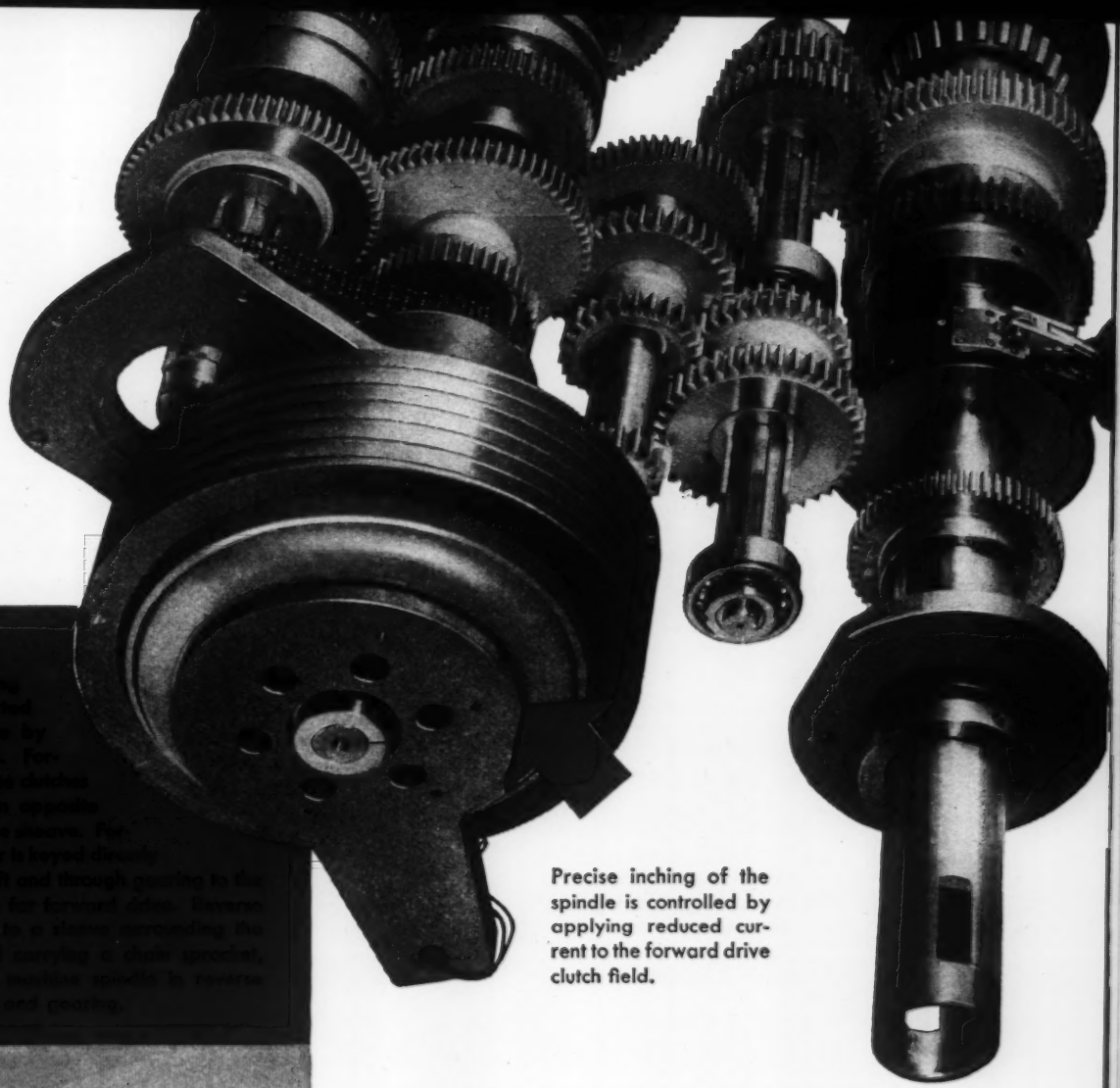
EASILY SOLVE POWER PROBLEMS LIKE THESE



Textile Machine—Brake magnet is stationary mounted to motor housing. Armature is mounted on drive pins to hub, which is keyed to a shaft which drives the brush roll. Perfectly synchronized stopping of eight rolls is accomplished by adjustment of individual rheostats in the control panel. Tearing and piling up of material between rolls has been eliminated while stopping the machine.

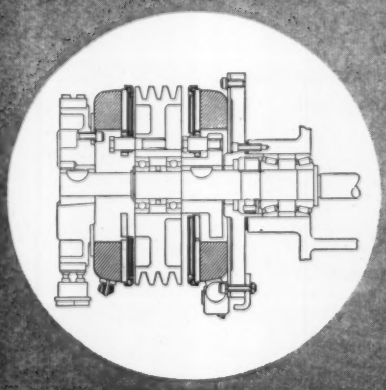
Mobile Power Unit—Electric clutch armature is mounted on three drive pins to a free-running sheave, driven from the prime mover. The field and collector ring assembly are keyed to the driven shaft through a hub and taper-lock bushing. Actuation of a conveniently positioned remote control switch energizes the field, which locks with the armature and engages the pump drive.

Guillotine Cutter—Two clutch armatures are mounted back-to-back on drive pins extending through a spider inside the drum. Current is supplied from a slip ring to clutch fields, which are mounted to a hub on the drive shaft. Clutches are actuated simultaneously by a rotating crank, controlling drum drive and conveyor feed. Adjustment of crank throw controls size of material cut.

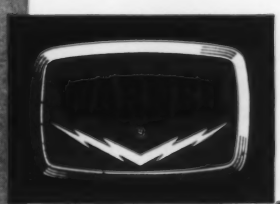


Precise inching of the spindle is controlled by applying reduced current to the forward drive clutch field.

When the forward drive clutch is operating and the reverse clutch is energized, the reverse clutch acts momentarily as a brake to decelerate the spindle, and then as a clutch to accelerate it in the opposite direction. The braking action is extremely fast, and the acceleration is exceptionally smooth.



Machine Tool—Free running sheave is used as mounting hub for clutch armature. Clutch magnet is mounted to collector ring assembly and keyed to headstock spindle. Brake magnet is stationary-mounted to machine casting, while armature is mounted on pins set in hub, which is keyed to spindle. Fast switching from clutch to brake permits improved inching and jogging, easier control.



Beat competition with

ELECTRIC BRAKES AND CLUTCHES

Warner Electric Brake & Clutch Co.
Dept. MD, Beloit, Wisconsin

Please send copy of your new Condensed Catalog No. 6212.

Name _____ Title _____

Company _____

Address _____

City _____ Zone _____ State _____

Circle 557

Multiple sources for "Things" not called SPRINGS

Yours to put to work . . . . our mechanical ingenuity and craftsmanship . . . . experienced in producing an infinite variety of metal parts in such fields as automation, communication, medical, electronics, safety devices, product development, etc. The capacity of ASC springmaking minds and machines is unlimited. Ask any Division to examine your sample or blueprint.

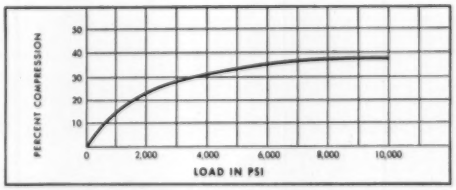
DIVISIONS OF ASSOCIATED SPRING CORPORATION
COAST TO COAST

- WALLACE BARNES COMPANY, BRISTOL, CONNECTICUT
- THE WILLIAM D. GIBSON COMPANY, 1800 CLYBOURN AVE., CHICAGO 14, ILL.
- RAYMOND Manufacturing COMPANY, CORRY, PENNSYLVANIA
- BARNES-GIBSON-RAYMOND, 40300 PLYMOUTH RD., PLYMOUTH, MICH.
- B·G·R COOK PLANT, ANN ARBOR MICHIGAN
- SEABOARD Coil Spring Div., 15001 S. BROADWAY, GARDENA, CALIF.
- OHIO DIVISION, 1825 EAST FIRST ST., DAYTON, OHIO
- WALLACE BARNES COMPANY, STATE FAIR BLVD., SYRACUSE 9 (Salina), N.Y.
- MILWAUKEE DIVISION, 341 E. ERIE ST., MILWAUKEE, WIS.
- DUNBAR BROTHERS COMPANY, BRISTOL, CONN.
- F. N. MANROSS AND SONS CO., BRISTOL, CONNECTICUT
- THE WALLACE BARNES CO., LTD., HAMILTON, CANADA

Divisions of

ASSOCIATED SPRING CORPORATION

Accopac fiber gasket won't dry out or shrink



COMPRESSIBILITY. N-820, less compressible than other Accopac materials, is recommended for heavy-duty applications where minimum flange pressures will be 2,000 psi and where temperatures will not exceed 250° F.

Combinations of heat and pressure that cause ordinary plant fiber gaskets to fail are handled successfully by Armstrong Accopac® N-820—a dense new material made by a patented Armstrong process. It requires a minimum flange load of 2,000 psi and seals at temperatures up to 250° F.

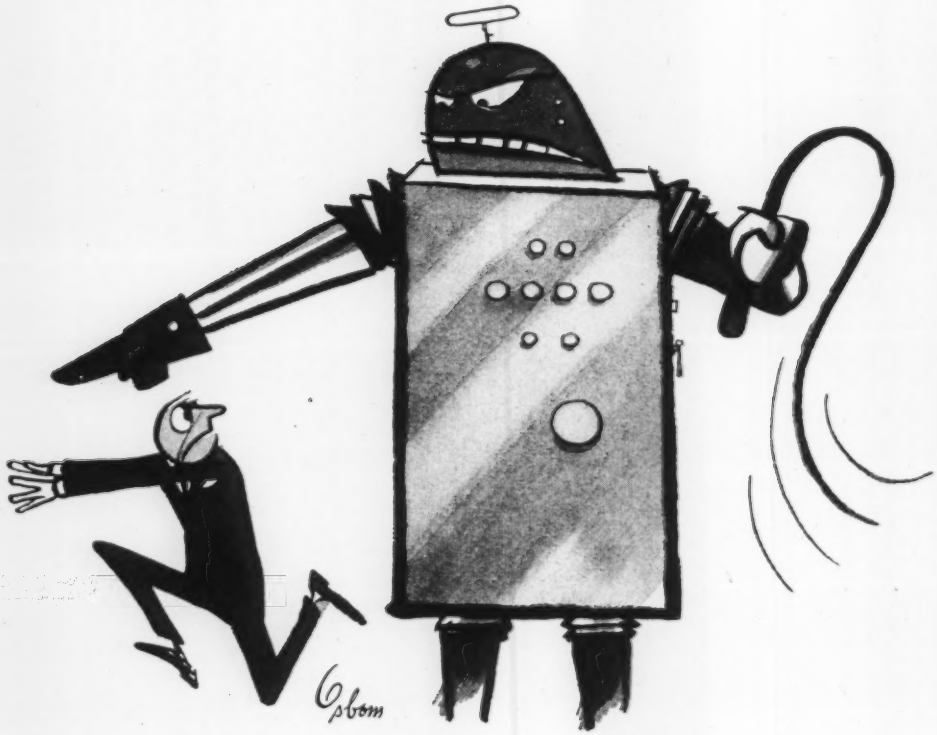
The special latex binder in N-820 will not leach out in alternately wet-and-dry applications. Shrinkage due to binder loss is eliminated because N-820's binder is non-volatile and non-extractable. It stays in.

N-820 is already being used successfully on a wide range of heavy-duty applications, often as an economical replacement for asbestos sheet packing where temperatures do not exceed 250° F. For more information and a copy of "Armstrong Gasket Materials," write to Armstrong Cork Co., Industrial Division, 7008 Dean Street, Lancaster, Penna.

Armstrong ACCOPAC

. . . used wherever performance counts

Circle 559 on page 19



Ruled by a Robot?

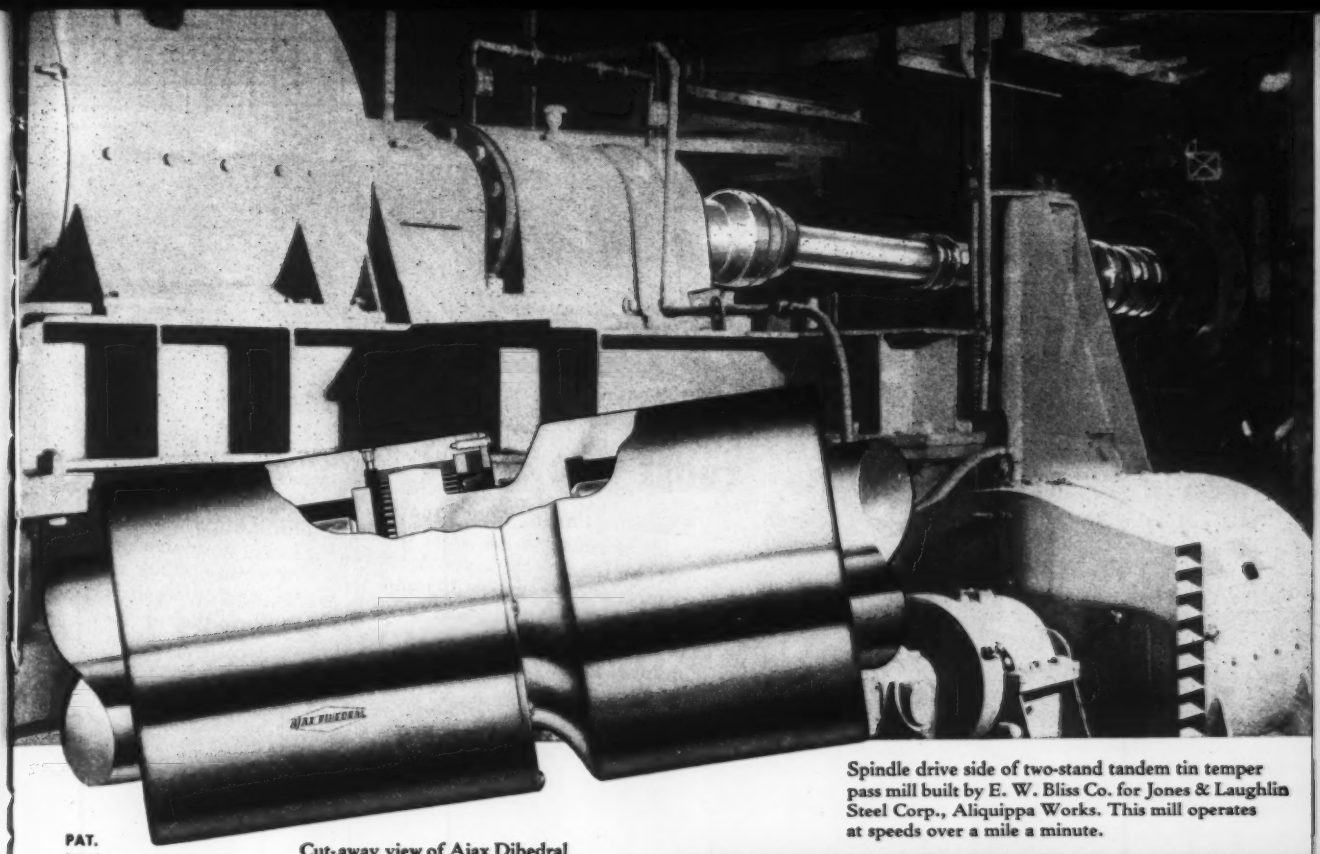
Dominated by a mechanical monster? Comes the revolution! Just write today and learn how 500 types and sizes of MPB's* such as these

BALL BEARINGS ACTUAL SIZE

are helping to revolutionize the size of robots, machines and precision instruments; making them smaller, lighter, smoother (and kinder!)

*MINIATURE PRECISION BEARINGS, INC.

3 Precision Park, Keene, New Hampshire



Spindle drive side of two-stand tandem tin temper pass mill built by E. W. Bliss Co. for Jones & Laughlin Steel Corp., Aliquippa Works. This mill operates at speeds over a mile a minute.

PAT. PEND.

Cut-away view of Ajax Dihedral Coupling showing arrangement of teeth.

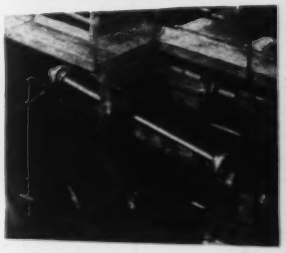
new FIRSTS *are being made with*

AJAX®

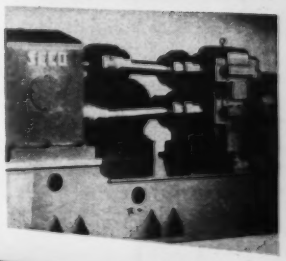
DIHEDRAL COUPLINGS

Designers and users of modern mills are achieving new high speeds (up to 7200 feet per minute), new high uniformity of gauge, new high quality finish, new high production and maintenance economies. Ajax patented dihedral tooth design is revolutionizing machine design and performance throughout industry. They are made in a wide range of types and sizes,—write for new Catalog No. 62 just off the press.

This 37″ x 80″ 2-high temper pass mill is cutting tonnage costs in the Fairless Works of the U. S. Steel Corp. at Morrisville, Pa.



Ajax Floating Shaft Dihedral Couplings solve angular drive problems on tilting tables for the Green River Steel Corp., at Owensboro, Kentucky.



Two Ajax Dihedral Floating Shaft Couplings driving SECO 48″ heavy duty slitter in operation at McLouth Steel Co., Detroit, Michigan, cutting ¼″ stainless steel at 100 ft. per min. with 16″ diameter knives.

AJAX FLEXIBLE COUPLIN[illegible]

WESTFIELD, N. Y.

SQUARE D OIL-TIGHT PUSHBUTTONS

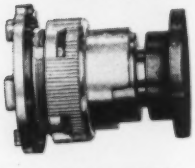
Everybody's Ahead with

THOSE WHO *Build* MACHINES

The *completeness* of Square D's pushbutton line makes a lot of sense to machine builders. Since any operator can be used with any contact block, every conceivable combination can be obtained with a minimum stock of packaged units. Another thing they like...the customer's enthusiastic approval of Square D control on the equipment they buy.

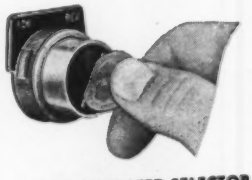
OIL-TIGHT OPERATORS

MOMENTARY CONTACT Guarded button in 7 colors.



MUSHROOM BUTTON 1⅜" or 2¼". Momentary contact. 7 different colors.

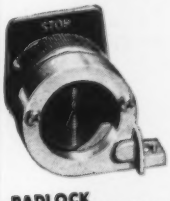
SELECTOR SWITCH 2 or 3 position with 4 different cams.



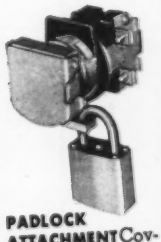
COIN OPERATED SELECTOR SWITCH Available in same selection as standard type.

KEY OPERATED SELECTOR SWITCH Discourages unauthorized operation.

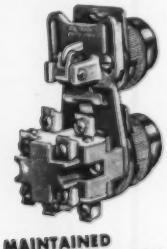
SELECTOR PUSHBUTTON combines selector switch and pushbutton. 2 or 3 position in red or black.



PADLOCK ATTACHMENT Latch type. For momentary contact buttons. Locks "off" position.

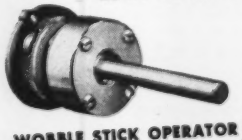


PADLOCK ATTACHMENT Cover type. Prevents depressing button.



MAINTAINED CONTACT ATTACHMENT Used with two operators and one contact block.

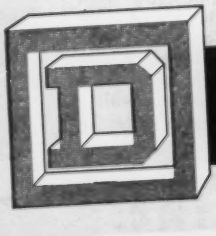
SELECTOR SWITCH LOCK-OUT Permits switch to be locked in any one of three positions.



WOBBLE STICK OPERATOR for momentary pushbutton operator. Ideal for emergency stop with pendant station.

NEOPRENE CAP for momentary contact button. Prevents liquids, dust and grit from working into pushbutton operator.

NOW...EC&M PRODUCTS ARE A PART OF THE SQUARE D LINE!



SQUARE D COMPANY

—Circle 562—

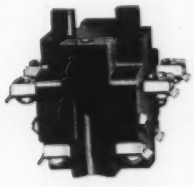
THIS MOST COMPLETE HEAVY DUTY LINE!

AND THOSE WHO *Buy* THEM

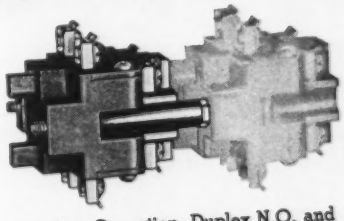
Performance and long life rank high with the men who buy and maintain the machines. Square D pushbuttons, designed to JIC and NMTBA standards, have been proven by severe tests involving millions of operations. They offer still other features...generous wiring space and exclusive "Slide and Swing" enclosure covers for easier, faster installations when machine operations are changed.

CONTACT BLOCKS and PILOT LIGHTS

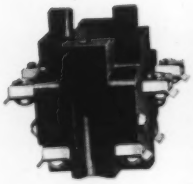
Single Pole N.O. and N.C. Contacts.



Duplex N.O. and N.C. Contacts.

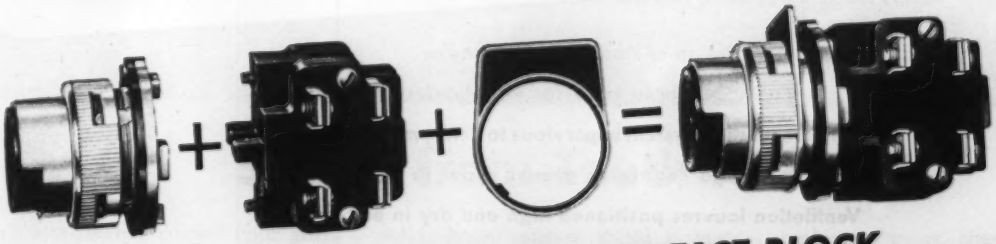


Tandem Operation. Duplex N.O. and N.C. Contacts with extended stems for combination with another block.

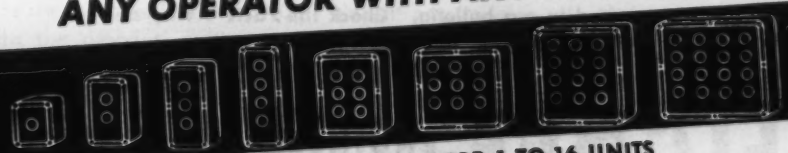


Duplex N.O. and N.C. Contacts with one N.O. circuit closing ahead of the other. Designed for 2-speed or sequence operations.

PILOT LIGHT. Generous illumination and wide-angle visibility. Greatly reduced filament burn-outs. No loosening of lamp under vibration. Six colors—red, amber, green, blue, white, clear.

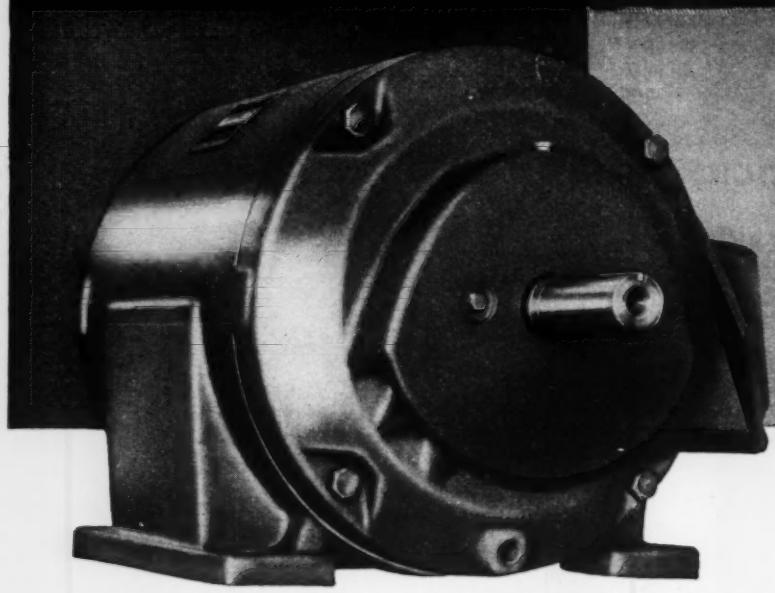


ANY OPERATOR WITH ANY CONTACT BLOCK



ENCLOSURES AVAILABLE FOR 1 TO 16 UNITS

Totally Protected



FROM CORE TO COVER

RELIANCE *Totally-Protected* MOTORS

The total protection concept of design and construction armors Reliance A-c. Motors against everyday hazards, with little or no maintenance. Total protection is made up of extra features like:

Slot cell insulation of Double Backed Mylar

Dynamically balanced rotor for vibrationless operation

Entire insulation system impervious to acids, moisture and oils

Metering plate regulates grease flow to bearing

Ventilation louvres positioned high and dry in end brackets

There are 100 of these extra core to cover protection features in Reliance Motors. Each point is covered in our bulletin, "Check the Facts". Why don't you write for one and get all the details?

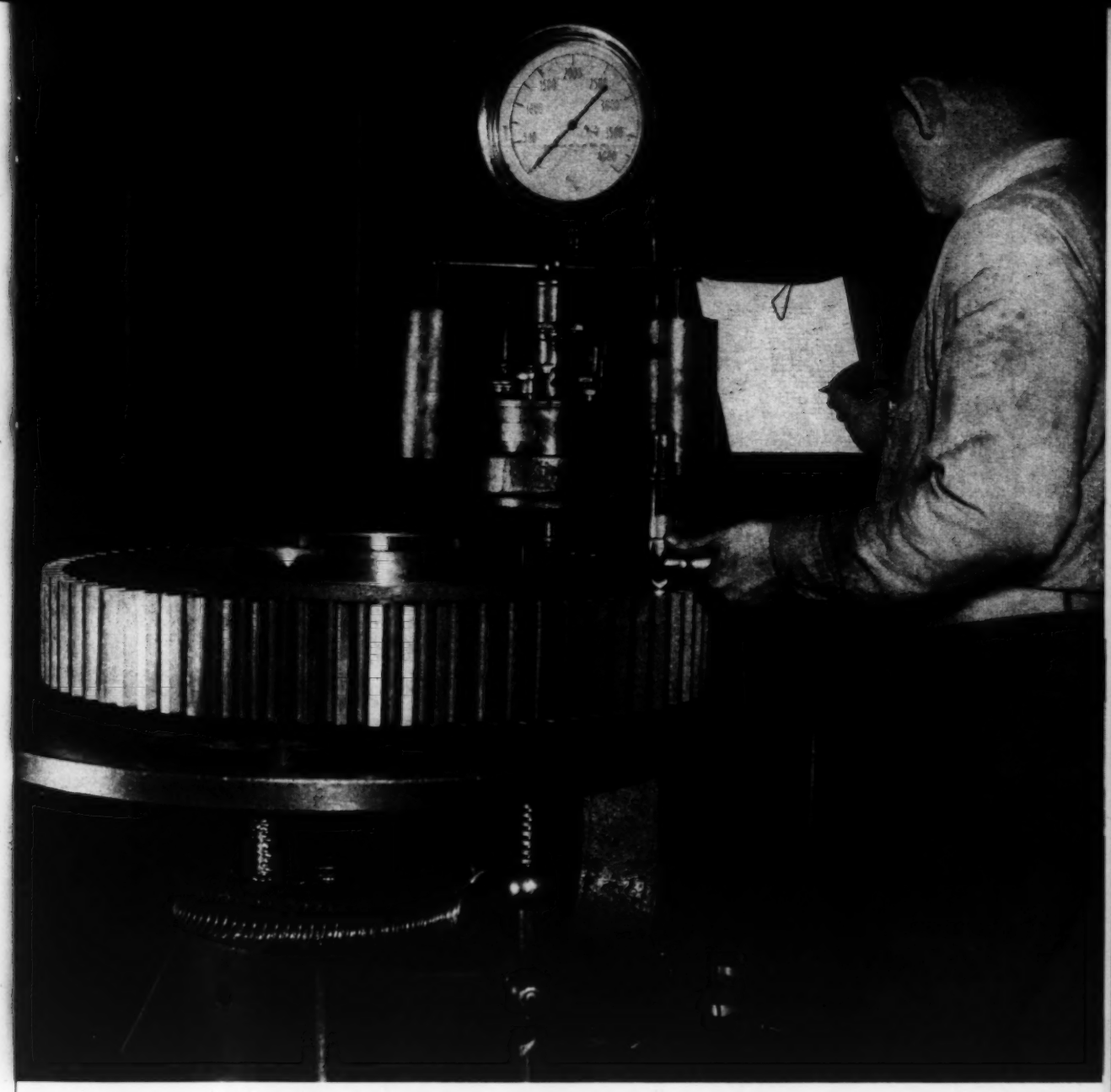
B-1510

RELIANCE ELECTRIC AND ENGINEERING CO.

DEPT. 288A, CLEVELAND 10, OHIO • CANADIAN DIVISION: WELLAND, ONTARIO

Sales Offices and Distributors in Principal Cities

Circle 563 on page 19



Sound from Teeth to Hub

This is a mighty rugged spur gear, as indeed it would have to be. It is slated for use in a diesel locomotive, and here the description "heavy-duty service" fits like a glove.

The gear and others like it were fashioned from Bethlehem circular steel blanks, which are both forged and rolled. The forging-and-rolling operation is a unique single-step process that results in uniform density, highly desirable grain flow. The solid, homogeneous metal is easy to machine. To sum it all up, the blanks are *reliable*, all the way through. They make possible gears that are sound from teeth to hub.

Bethlehem forged - and - rolled blanks are produced in many sizes, the usual range being 10 to 42 in. OD. In addition to their uses in the making of gears, they are also recommended for sheaves, crane wheels, and other circular steel products. A wide choice of sections is available. Write for the full story.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

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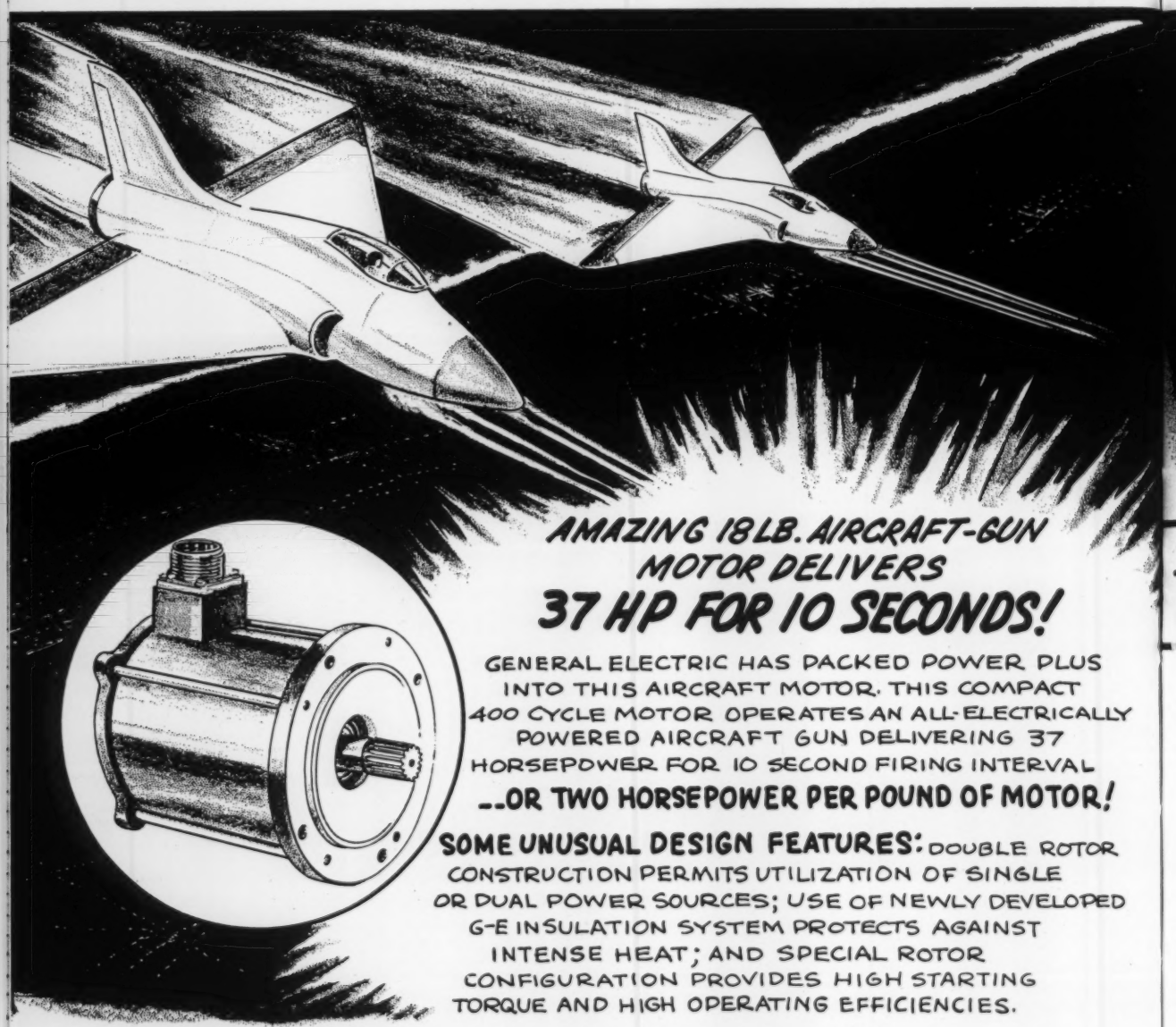
DESIGN SOLUTIONS with G-E



AMAZING 18 LB. AIRCRAFT-GUN MOTOR DELIVERS 37 HP FOR 10 SECONDS!

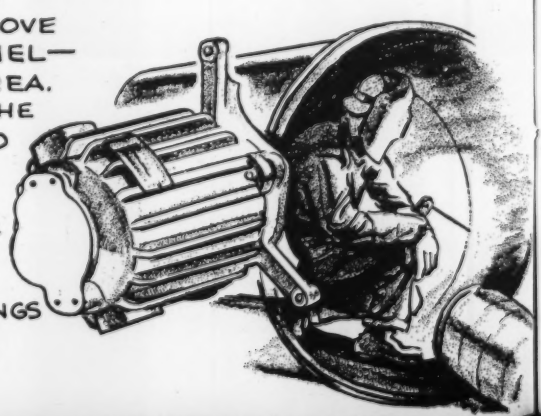
GENERAL ELECTRIC HAS PACKED POWER PLUS INTO THIS AIRCRAFT MOTOR. THIS COMPACT 400 CYCLE MOTOR OPERATES AN ALL-ELECTRICALLY POWERED AIRCRAFT GUN DELIVERING 37 HORSEPOWER FOR 10 SECOND FIRING INTERVAL

...OR TWO HORSEPOWER PER POUND OF MOTOR!

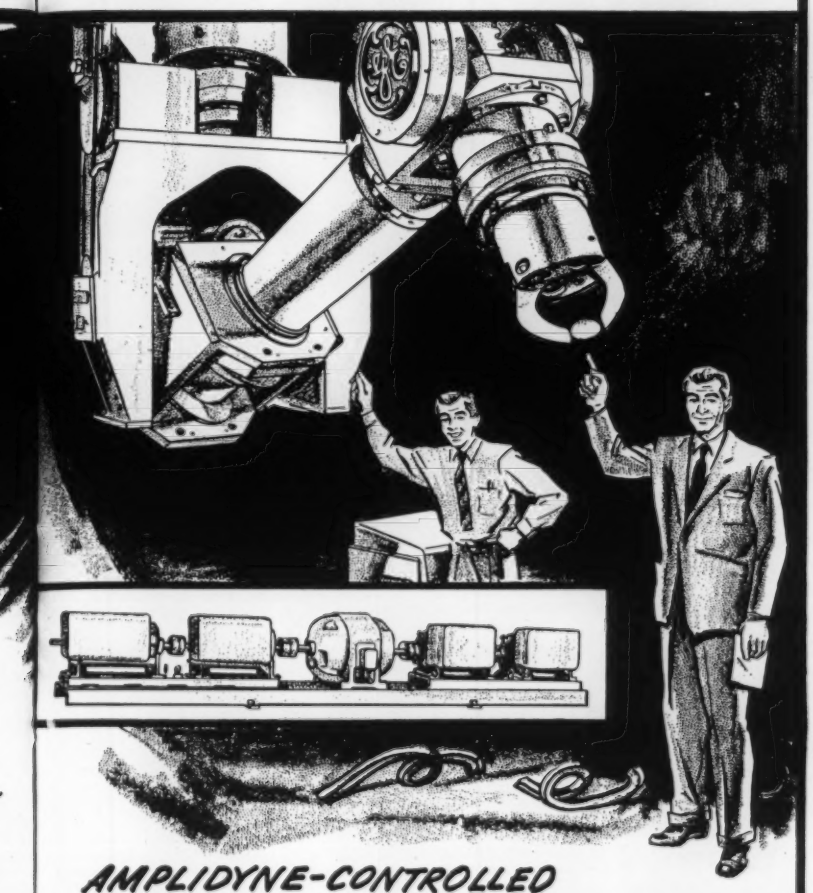
SOME UNUSUAL DESIGN FEATURES: DOUBLE ROTOR CONSTRUCTION PERMITS UTILIZATION OF SINGLE OR DUAL POWER SOURCES; USE OF NEWLY DEVELOPED G-E INSULATION SYSTEM PROTECTS AGAINST INTENSE HEAT; AND SPECIAL ROTOR CONFIGURATION PROVIDES HIGH STARTING TORQUE AND HIGH OPERATING EFFICIENCIES.

THIS SPECIALLY COOLED G-E MOTOR OPERATES WHERE DEPENDABILITY CAN MEAN LIFE ITSELF!

THIS G-E MOTOR DRIVES A VENTILATOR TO EXHAUST WELDING FUMES WHICH CAN PROVE DEADLY IN THIS UNDERGROUND CABLE TUNNEL—OR IN A SHIP'S HOLD OR ANY ENCLOSED AREA. DEPENDABILITY IS IMPERATIVE. DESIGN OF THE TOTALLY-ENCLOSED MOTOR (TO BE MOUNTED INSIDE BLOWER) POSED THE PROBLEM OF DISSIPATING MOTOR HEAT. G-E ENGINEERS SOLVED THE PROBLEM BY BUILDING THE MOTOR WITH SPECIAL HEAT-DISSIPATING RIBS. AN INTERNAL FAN TRANSFERS HEAT FROM THE WINDINGS WHILE THE BLOWER ITSELF BRINGS COOLING AIR OVER THE RIBBED HOUSING.



specialty motors



AMPLIDYNE-CONTROLLED MECHANICAL ARM HAS FINGERS THAT TWIST STEEL OR HANDLE AN EGG

A G-E MULTIPLE AMPLIDYNE SET CONTROLS THE MUSCLES OF O'MAN, AN OVERHEAD MANIPULATOR BUILT BY GENERAL ELECTRIC. O'MAN CAN KNOT STEEL BARS, YET DEMONSTRATES A DELICATE TOUCH WHEN IT LIFTS AN EGG WITHOUT BREAKING IT. O'MAN IS THE WORLD'S LARGEST MECHANICAL ARM BUILT TO SUBSTITUTE FOR HUMAN BRAWN IN RADIO-ACTIVE AREAS.

A SYSTEM CONSISTING OF G-E DEVELOPED AMPLIDYNES PROVIDES 20 TO 1 SPEED CONTROL, DYNAMIC BRAKING, CURRENT LIMIT OVERLOAD PROTECTION, AND ADEQUATE AMPLIFICATION TO KEEP CONTROLLER SMALL.

AVAILABLE: COMPLETE SMALL MOTOR ENGINEERING ASSISTANCE FOR YOU!

HERE'S THE SPECIAL ATTENTION YOUR SMALL MOTOR PROBLEMS GET AT G.E.

1

YOUR LOCAL G-E APPARATUS SALES ENGINEER LEARNS ALL ABOUT YOUR MOTOR NEEDS.

2

HE CALLS A TEAM OF FACTORY ENGINEERS WITH YEARS OF MOTOR APPLICATION EXPERIENCE.

3

AT THEIR DISPOSAL ARE G.E.'S COMPLETE DEVELOPMENT AND TESTING FACILITIES.

4

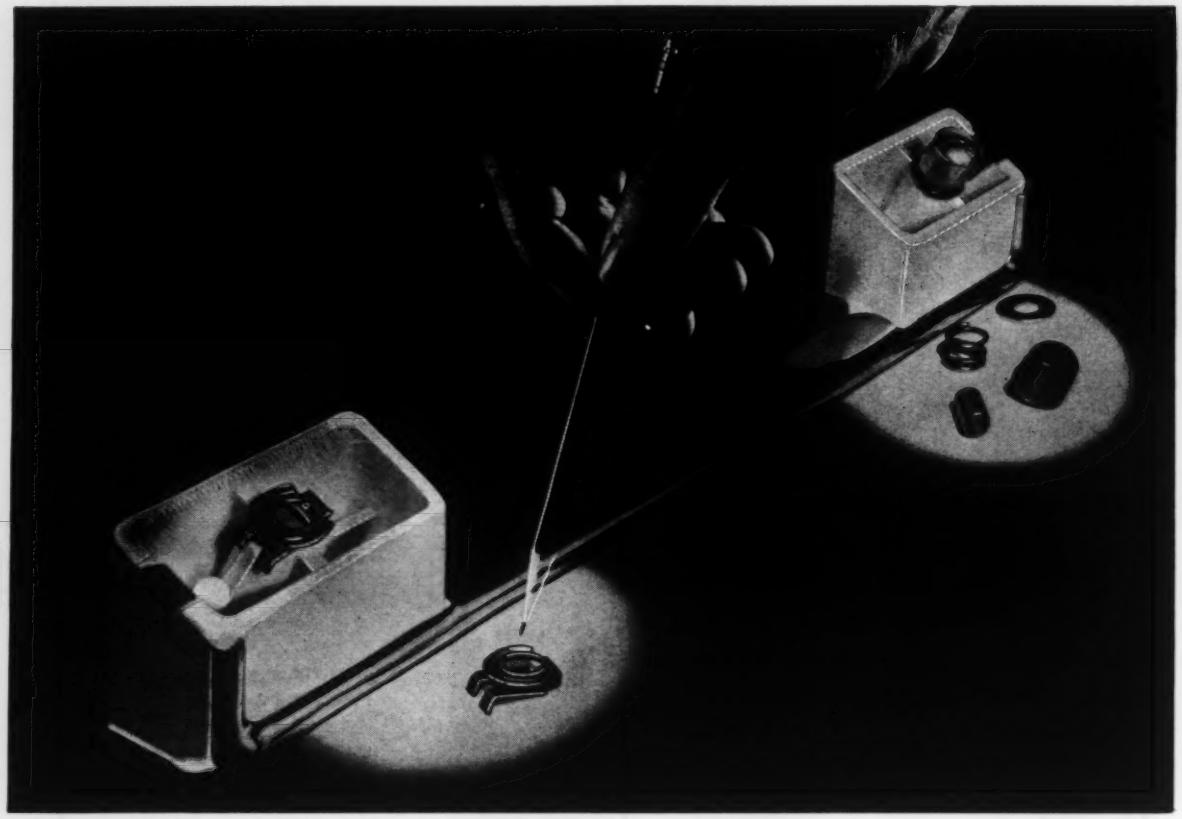
IN SHORT ORDER A SAMPLE G-E MOTOR IS READY FOR TESTING ON YOUR PRODUCTS.

FOR THIS COMPLETE HELP, CONTACT YOUR NEARBY G-E APPARATUS SALES OFFICE.

WRITE FOR MORE INFORMATION COVERING G-E EQUIPMENT DESCRIBED IN THIS AD TO GENERAL ELECTRIC CO., SECT. 633-3, SCHENECTADY 5, N.Y.

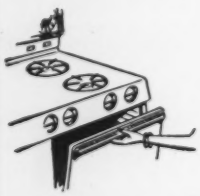
GENERAL ELECTRIC

Circle 565 on page 19



Engineered by Tinnerman...

One-Piece SPEED CLIP® replaces 4-part fastener, helps assembly and shipping... and saves money!



Four separate parts plus screw were required to fasten each end of the removable door handles on kitchen ranges manufactured by the Caloric Appliance Corporation, Topton, Pennsylvania.

Tinnerman fastening specialists teamed up with Caloric designers to eliminate 3 of the parts!

Now . . . a special one-piece, multi-purpose SPEED CLIP plus screw do the same job more efficiently and at lower cost, and reduce small parts handling. Faster, easier assembly... fewer parts to buy, inventory and handle. Packed inside the oven for safe shipment with SPEED CLIPS in place, the door handles are dealer-applied in far less time, can be easily removed by the housewife for cleaning.

The resiliency of the spring steel SPEED CLIP prevents crazing or chipping, enables it to absorb varying panel thicknesses and porcelain enamel build-up. Changeover was made without retooling or redesigning door handle or keyhole-shape mounting holes.

Find out now where SPEED NUT brand fasteners belong on your assembly line. There are more than 8000 variations to choose from. Call your Tinnerman representative for complete details and write for our Fastening Analysis Bulletin No. 336.

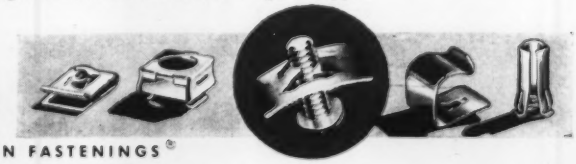
TINNERMAN PRODUCTS, INC. • Box 6688, Dept. 12, Cleveland 1, Ohio

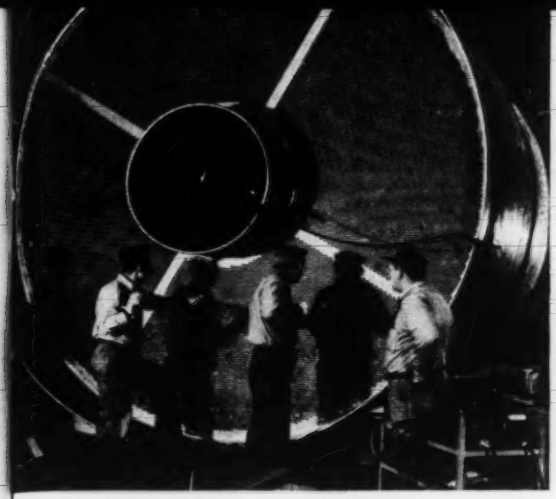
Canada: Dominion Fasteners, Limited, Hamilton, Ontario. *Great Britain:* Simmonds Aerocessories, Limited, Treforest, Wales. *France:* Simmonds, S. A., 3 rue Salomon de Rothschild, Suresnes (Seine). *Germany:* Hans Sickinger GmbH "MECANO", Lemgo-i-Lippe.

TINNERMAN

Speed Nuts

FASTEST THING IN FASTENINGS®





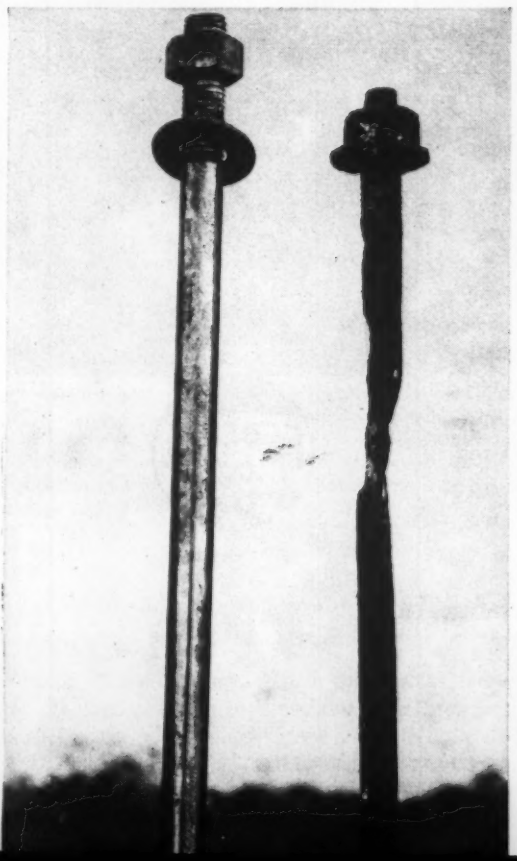
FOR HIGH TEMPERATURE STRENGTH. This looks like a sieve, but actually it is a Stainless Steel plate punched with 25,400 holes, and it makes up the end plate of a chemical plant heat exchanger. After the tubes were inserted the exchanger was placed in high-temperature, intensely corrosive 24-hour service. It was made by the Nooter Corporation, St. Louis.

NOTHING *can equal* *Stainless Steel*

for its combination of desirable properties

No other design material can match Stainless Steel in its combination of desirable properties: corrosion resistance, strength and hardness, beauty, cleanability and easy fabrication. When seeking a source of supply, remember that United States Steel offers you the widest range of types, finishes and sizes.

FOR CORROSION RESISTANCE. Rare Earths, Inc., produces such valuables as cerium, lanthanum and praseodymium by means of an elaborate chemical separation process. In the filter press, corrosion destroyed carbon steel plate rods in six months. Stainless Steel rods were installed over six *years* ago, and are still in fine condition.



FOR TAKING A BEATING. These are 8th grade students from Dormont, Pa., public schools in a domestic science class. The sink tops were made by Pride Mfg. Co., Pittsburgh, from USS Stainless Steel. Says Pride, "These Stainless sink tops are ideal for school use. We've seen some 20-year-old sinks that still look as good as new."

UNITED STATES STEEL CORPORATION, PITTSBURGH · AMERICAN STEEL & WIRE DIVISION, CLEVELAND
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO · NATIONAL TUBE DIVISION, PITTSBURGH
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS STAINLESS STEEL

SHEETS · STRIP · PLATES · BARS · BILLETS
PIPE · TUBES · WIRE · SPECIAL SECTIONS

USS

UNITED STATES STEEL

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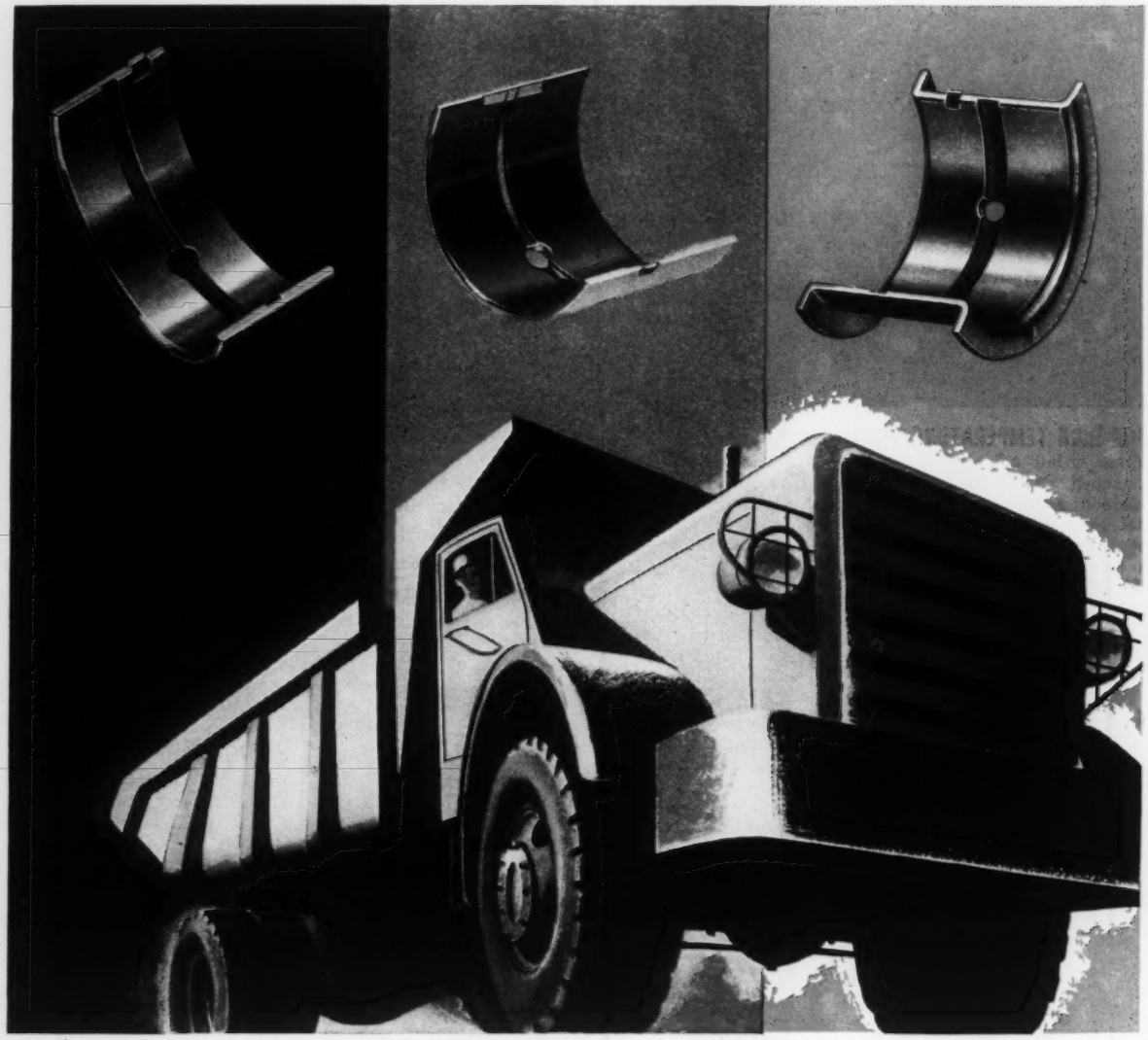


RESEARCH • DESIGN • METALLURGY • PRECISION MANUFACTURING

High-speed, high-temperature, heavy-duty engines are a real test of engine bearing performance. To meet these requirements calls for watch-like precision in bearing production, with continuous test-and-inspection at every major step in manufacture. With over half a century's specialization in sleeve bearing production, by the thousand or the million, we are equipped to meet these modern requirements.

FEDERAL Mogul

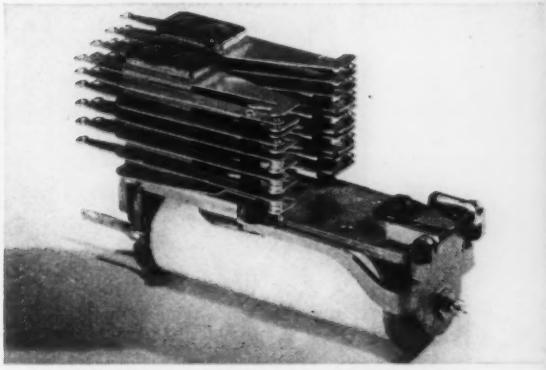
SINCE 1899

FEDERAL-MOGUL DIVISION

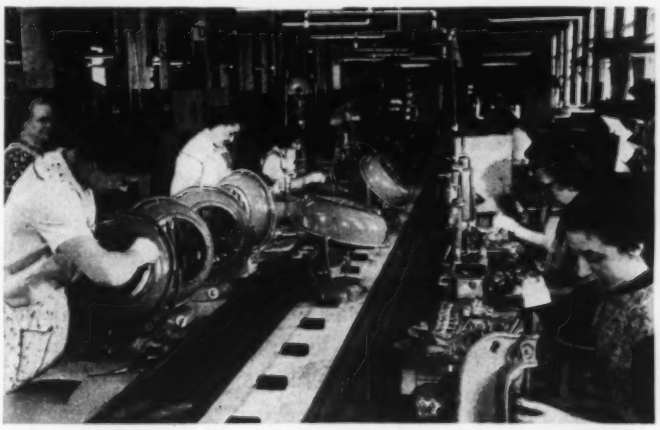
FEDERAL-MOGUL-BOWER BEARINGS, INC., 11045 SHOEMAKER, DETROIT 13, MICHIGAN

Why Design Engineers Prefer PHILLIPS CROSS RECESSED HEAD SCREWS

INCREASED SALES APPEAL is just one benefit credited to Phillips screws by Portable Electric Tools, Inc., prominent Chicago manufacturers. Engineer Shoemaker of this firm says, "Phillips screws reduce rejects, upgrade production, give a tighter bond and add a definite sales advantage to our finished products."



IN A MILLION ELECTRICAL RELAYS produced annually by the C. P. Clare Co. of Chicago, Phillips head screws aid product performance as well as production. Clare officials state that Phillips screws, besides speeding assemblies and improving product appearance, have the prolonged holding power vital to efficient relay operation.



"WINDSTREAMER" FANS, made by A. C. Gilbert Co. of New Haven, Conn., are protected against damage in assembly by the use of Phillips head screws. "For tight fit, neat appearance and production efficiency, Phillips screws are unequalled," is the report from this leading manufacturer of toys and electrical appliances.

MANUFACTURERS OF PHILLIPS CROSS-RECESSED-HEAD SCREWS

THE FASTENERS OF TODAY...
AND OF THE FUTURE
X marks the spot
the mark of extra quality

Pledged to highest standards...

The Phillips Screw manufacturers listed here cooperate to turn out a uniformly high standard of quality. As sponsors of the Phillips Cross-Recessed-Head Standards Committee they adhere to the established dimensional standards, gauges, and gauging methods which will best serve industry.

Members of Screw Research Association

American Screw Company • Atlantic Screw Works, Inc. • The Blake & Johnson Co. • Central Screw Company • Continental Screw Co. Elco Tool and Screw Corporation • Great Lakes Screw Corp. • The H. M. Harper Company • The Lamson & Sessions Company • National Lock Company • The National Screw & Manufacturing Company • Parker-Kalon Division, General American Transportation Corporation Pheoll Manufacturing Co. • Scovill Manufacturing Company • Shakeproof Division Illinois Tool Works • The Southington Hdwe. Mfg. Company • Sterling Bolt Company • Universal Screw Company • Wales-Beech Corporation

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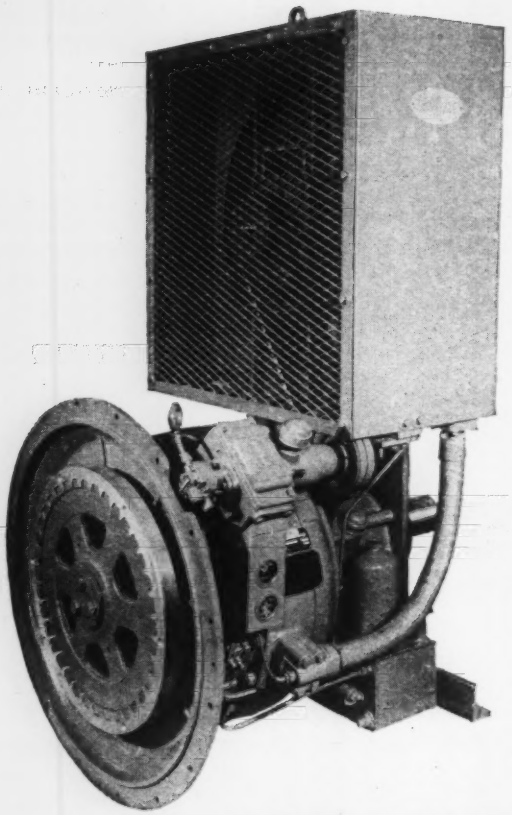

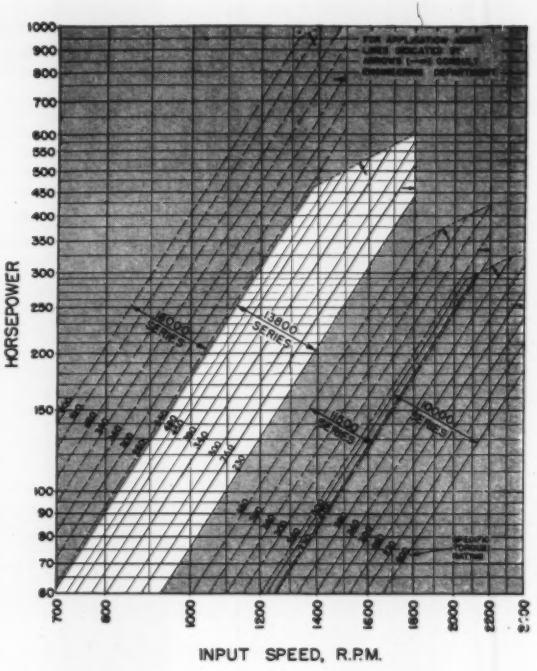

ENGINE APPLICATIONS

Mfr.—Model	Mfr.—Model	Mfr.—Model
Allis-Chalmers 8DC2505	Climax R165	Mercedes-Benz MB836-Bb
Allis-Chalmers 6PC1879	Cummins LR-6	Murphy 112
Allis-Chalmers 6DCS1879	Cummins NVHS-12	Murphy 120
Allis-Chalmers 6DC1879	Cummins VT 12	Murphy 121
Allis-Chalmers 8PC2505	Deutz BA8M517	Murphy 122
Caterpillar D342	Fairbanks 38F5½-4	Murphy 124
Caterpillar D353	Gardner 6L3	Murphy 224
Caterpillar D3750-NA	Hall Scott V-12	Murphy 322
Caterpillar D3750-BB	Hercules DRXH8-DTS	Murphy 324
Climax R-61	LeRoi F1500	Sterling V-D6
Climax R-67	LeRoi H-2000	Waukesha WADB
Climax R-75	M.A.N. SWV175/122-A	Waukesha WAKB
Climax V-80	M.A.N. 6WV175/122-A	Waukesha WADBS
Climax V-85	Mercedes-Benz MB836-B	Waukesha LRDB

ANNOUNCING . . . the new Twin Disc 13,800 Series Three-Stage Torque Converter

By W. B. Gibson, Sales Manager

Hydraulic Division, Twin Disc Clutch Company, Rockford, Illinois

With announcement of the new 13,800 Series, the Twin Disc Clutch Company *now* provides a three-stage torque converter for every horsepower range from 40 to 1,000—offering four distinct sizes, with a total of twenty-nine capacities, through internal blading variations.

Designed specifically to accommodate a large number of engines for which previous models were not ideally suited (see listing above)—this new series is planned around a *simple basic unit*—with easy-to-add components which produce ten specific models. This arrangement permits extreme flexibility and speedy interchange of components to provide a model specifically adapted to a wide variety of applications.

The 13,800 Series provides two *output* arrangements. There is *one standard output shaft assembly* designed for maximum side pull loads up to the full capacity of the converter. On this particular output shaft assembly, an output governor take-off is available. There is also *one standard output flange* designed for universal joint or flexible gear coupling drive.

There are also three *input* arrangements—spider drive, incorporating a rubber block drive — which withstands normal misalignment conditions without imposing undue loads or stresses on the input shaft or the engine crankshaft; clutch assembly and independent mounting. In addition to being offered in ten different models, this new torque converter can be adapted, with appropriate engine speeds, to all engines in the 60 to 600 horsepower range by internal blading variations.

Get all the facts on the advantages of torque converter drive in equipment that *you're* planning or designing. Write *now,* to the Hydraulic Division, Rockford, Illinois.

Twin Disc Clutch Company
Racine, Wisconsin
Hydraulic Division, Rockford, Illinois

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MACHINE DESIGN
August 23, 1956

What Is Good Design?

ACADEMIC discussion of this question would probably lead to some such conclusion as this: Good design is the balanced consideration of performance, producibility, cost, appearance, reliability, maintainability, etc., and the integration of all these factors in the final product.

This is all very fine—until we begin to examine cases.

Joe is a top-notch analysis man. His adherence to fundamentals and his rigorous application of them make him a hard man to beat. Basic theory, development, calculation, reflective judgment—all contribute to a high-class solution to the problem. Piles of paper and days of work pay off—if the job warrants a high-class answer.

But Joe is charged with responsibility for the whole job—not only the challenging head work. He must deal with a host of other factors, too: relating the design to his shop's production facilities, picking materials, deciding on fastening or joining methods, and other such practical matters. To Joe, however, these are mundane everyday matters—scarcely worthy of more than routine consideration.

Take fasteners, for example. Joe knows all about nuts and bolts, rivets, etc.—he thinks. They're simple hardware items. He can pick 'em off the top of his head, or check a catalog or two. No need wasting time on the easy stuff, he says to himself.

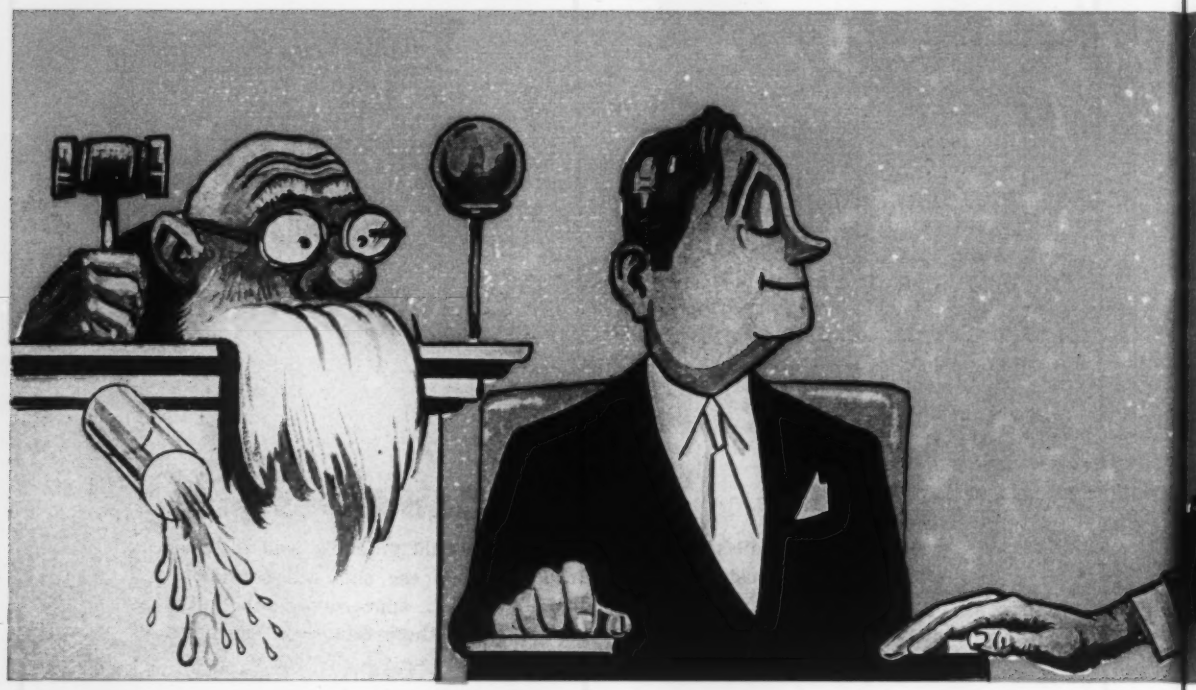
His approach to this part of the job can be just as badly askew as his happy high-class analysis of a situation that doesn't require one.

Joe doesn't exist, of course, but he has survived here long enough to make a point. The point is: We all have our personal biases and foibles on what's important—or unimportant—to the job at hand. Are we so practical that we overlook the benefits of fancy but powerful techniques, so long-haired we can't see the shop's viewpoint, so dependent upon our own experience that we can't hear another's suggestion . . . ?

In the final analysis, good design—the balancing of all factors—seems to depend mainly upon three old-fashioned commodities: a questioning attitude, an open mind, and common sense.

Ben Hummel

ASSOCIATE MANAGING EDITOR



The Engineer in Court . . .

EVERY engineer can have his day in court. If he is an engineer in private practice or teaching in a university, he will probably have many days in court if he wants them. That is because he is a ready-made helper for the lawyer who takes a case involving industrial property damage, personal liability or patent rights. The lawyer needs an engineer to evaluate the technical aspects of a case—to help him ascertain whether he has a good sueable case if he is representing a plaintiff, or has a good defense if he is representing a defendant. The engineer is the lawyer's technical eyes and ears while he fashions his case to the law. As a technical expert, the engineer will handle the engineering problems and gladly leave the law to the lawyer.

How will an engineer be found?

If his case involves mechanical, electrical or chemical equipment, a lawyer will look for an expert in the plant of its maker—if there is no chance that its maker will be discredited. In such a case, an engineer's employer will want him to testify because it makes for good public relations and it is also good publicity for the company.

If a case involves mechanical, structural or electrical codes, such as the National Electrical Safety Code of the National Bureau of Standards or the National Electrical Code of the National Board of Fire Underwriters, he will look for an expert in an engineering college. Frequently he may want to find a witness who has no industrial connections because a judge or jury will expect such a witness to be free from prejudice.

How will the expert help?

An expert witness is in a unique group. All other witnesses are allowed to testify only about what they did or what they perceived through one or more of the five physical senses—what they saw, heard, smelled, tasted, or felt. The expert is unique in that he may moreover testify as to his opinion.

Suppose the lawyer is defending a manufacturer client against whom an Industrial Commission claim has been filed by a former employee. As an expert, the engineer (and the lawyer) have, of course, beforehand carefully examined the plaintiff's claim. She has claimed that she was injured in her regular line of employment which required her to start a machine by pressing two large palm type electric switches located well apart so that the use of both hands was necessary. At the time of sustaining this injury, she says she was pressing the necessary palm type switches when one of them "back fired" throwing her hand and arm back over her shoulder so hard that the elbow was wrenched, caused to swell rapidly, and thereafter

By E. E. Kimberly, *Professor of Electrical Engineering*
The Ohio State University, Columbus, O.

or how to be an expert before judge and jury

disabled. The engineer, as an expert, was not there, of course, and can only have an opinion. He has examined the switch and found nothing wrong with it. Could this thing have happened? It is his opinion as an expert that will count.

An expert's qualifications

When the plaintiff's lawyer has finished his parade of witnesses in court, the defendant's lawyer will begin his defense. In his calling up of witnesses for direct testimony, the defendant's lawyer will place his expert witness at that key time when the expert's testimony will most upset the plaintiff's case. When the engineer has been "sworn" and has taken the stand, the first thing his lawyer must do is "qualify" him. The lawyer must convince the jury, if any, or judge that the engineer is an expert on the subject matter and fully qualified to have a valuable opinion. The lawyer will ask the expert's name, place of residence, how long he has lived there, what education he has had, what he has written for publication, what national honors and other recognition he has received, what his job is now and how long he has held it, what practical experience he has had in the subject field to qualify him as an expert, and whether he is a registered professional engineer licensed to practice where the trial is held. The questions of his direct examination will then follow.

Direct examination

In the plaintiff's statement of his case, his lawyer will have stated not only what the injury is alleged to have been but also on what grounds he considers it an injury and, also, on what he relies in law or in applicable codes of conduct to prove his point. The lawyer for the defense will take the plaintiff's complaints one by one, form each into a direct question, and ask his expert for an opinion. These questions must be carefully worded, as he and the expert should have previously agreed, or they may misfire and bring a reply that will be adversely understood by the jury or judge. Some lawyers are not sufficiently thorough in preparation of questions. It is the expert's duty to the lawyer and to the court, as well as to himhelf, to insist upon careful preparation of questions and answers that can be understood and relied upon.

The engineer's ability to make himself clear with simple words is important here. The jury will consist of merchants, mechanics, laborers, politicians or any others from our American cross section. They will be hard-put to understand the technical wording of the testimony and will be thankful if the expert speaks clearly and in homely words. In fact in the end, if they do not understand the case, they are likely to be influenced more by the expert's general poise and demeanor

before them than they are by anybody's words. In this direct examination of the expert, his lawyer is limited somewhat in his scope of questioning by what the plaintiff has claimed. If, for example, the plaintiff's lawyer has claimed that the injury to his client occurred because the defendant failed to follow the recommendations of good practice as published in one of the national safety codes, then the engineer's lawyer may ask him some questions involving that code and he should anticipate them.

After the expert is questioned about the details of the case, his direct examination will probably end with his answer to a so-called hypothetical question. This question will take the form of a group of imaginary or hypothetical conditions or circumstances presented in some chosen relationship applicable to the case. The expert will be asked to give his opinion as to the result. If the plaintiff's lawyer objects to the question and the judge sustains the objection, that is usually the end of the direct examination. If the objection is not sustained, the expert will answer.

The cross-examination

For every direct examination there is the privilege of a cross-examination by the opposing lawyer. The battle of wits waxes hottest here. The cross-examination of an expert has only one purpose—to discredit his testimony. If when he qualified he claimed to be an engineer and it is shown that he has not taken the legal steps necessary to call himself an engineer, then he will have been impeached and the defendant's case would have been better off without him. However, some lawyers hesitate to discredit a witness on the grounds of his not being a registered engineer lest it swing the sympathy of the jury to the hapless witness. If it can be shown that his experience, while perhaps broad, has been not applicable to the case at trial, his testimony will be weakened. He should have so advised his lawyer in the beginning. An expert must beware of a dogged determination to have all of his testimony favorable to his side. In one such case where an expert witness was testifying for his employer, a power utility, he found himself so involved in cross-examination that he was obliged to testify that in his opinion it was possible for a squirrel to have his tail burned off on a high-tension power line without being hurt.

To accept the case or not?

Before he offers to become an expert witness, an engineer must convince himself that he believes in the stand he is to take and that he is participating in no fraud. To do that, he must carefully question the lawyer who asks him to help with the case. If it is a case where the facts are little known or the trail is old and cold, and the lawyer is really interested only in getting the case before an ignorant but sympathetic jury or settling out of court through intimidation, then it should be avoided. In one case where a home refrigerator went through the burning of the home, the remains were hauled to a sinkhole to erode in the weather for three years before the engineer was called in to try to prove that the fire was caused by a defect in the refrigerator. If he had tried to testify for the plaintiff sueing the refrigerator maker, his taut imaginative reconstruction of the occurrence would have been pitiful before a jury.

There is a pitfall, too, that must be mentioned. The engineer may investigate the facts in a case and decide he wants nothing to do with any court trial of it. He innocently writes a report and opinion to his lawyer, tells his feelings and considers the matter closed. Comes the trial, and the lawyer has a subpoena issued for the engineer's appearance. He reluctantly appears, takes the witness stand and finds himself asked on direct examination if this, a plaintiff's exhibit, is a copy of a report he wrote. He admits it is. His lawyer then pulls certain statements, favorable to his case, out of context and asks if he wrote them. He admits he did—but! But he may get no further. True, he is obviously a reluctant witness but the lawyer has made the point of his testimony to the jury. A lawyer is unbelievably bold to use those tactics, though, because a seasoned experienced expert witness can ruin him at his own game. It is merely one of the tricks.

Another trick that may be used is based on a hypothetical question asked on cross-examination. Let us suppose that a power utility is being sued on grounds of negligence arising from the death of a farmer who was killed when the radio antenna he was trying to erect within five feet of a high-tension electric line on his own farm fell into the line while he was holding it. In that case the defendant's expert would probably testify that the clearance of the power line from ground was enough for safety according to the best operating practice as attested by the National Electrical Safety Code, and that the erection of a high and dangerous antenna was beyond the scope of anticipation. But, on cross-examination, he may be asked a loaded question: "If this farmer had seen his neighbor erect a similar antenna likewise close to this power line two years before his accident,

and knew that the power company had ignored that antenna and had not warned the neighbor of its danger, don't you think this man who was killed had reason to believe that he could erect his antenna in safety to himself and that the power company was negligent in permitting the first antenna to remain?"

If his answer to that question is "No," then he has shown biased testimony, because almost any

jury would feel the defendant was guilty of neglect by condonement. If his answer is "Yes," then he has told the truth but abetted a deception because the jury may overlook the fact that there may actually never have been an antenna on the neighbor's farm—only in the opposing lawyer's mind. After the expert's answer, the cross-examiner may excuse him at once and so infer that he has just settled the case in the plaintiff's favor. It is, of course, a frustrating situation, but such tactics are wholly within both legal and ethical bounds for the lawyer.

Will the expert be paid?

If an expert testifies for a going concern, such as a manufacturer or an insurance company, he will surely be paid for his services. If he testifies for an individual, he will likely be paid because he will likely win. He will likely win because he has the right of discretion in accepting the case and can decline to enter it if the prospects of winning are not good. The lawyer may be in the case on a contingency basis. That is, his being paid is contingent upon his winning. His client may be indigent and recognized as unable to pay if he loses. A lawyer's code of ethics permits him to do that, but the code of the engineer does not permit him to do it. The difference is that a contingent arrangement is not supposed to affect a lawyer's judgment in attending to his client's legal interests. But presumably an expert's judgment or his honesty might be bent, or the quality of his service prejudiced, if his being paid depended upon his side's winning. He must remember that the lawyer engaged him not as his employer but as an agent of the client to whom he must look to be paid. The lawyer is not obliged to see that the witness is paid. If the expert's side loses its case, and his client is indigent, then there is nobody for him to collect from and, even though he may not have known it, he actually was working on a contingency basis.

If an expert lives in one state and works with a lawyer in another state, the lawyer will accept the bill for witness fees and expenses and pass it on to his client or simply pay it from his client's funds if any are available. If the client has the means of paying his expert but simply does not do it, then there are two choices of action. The expert may post the court costs of a suit as required because he is from another state and sue the lawyer's client or he may charge it to experience. Anticipating dishonesty is never a pleasant pastime but it is still well to know some of the form it can have. In a lifetime of service as an expert witness, an engineer will most likely not once be asked to color his testimony in favor of a client nor find it expedient to accept less than a reasonable fee. Some lawyers tell their clients at the start that they must be prepared to pay the expert witnesses, win or lose.

Patent actions

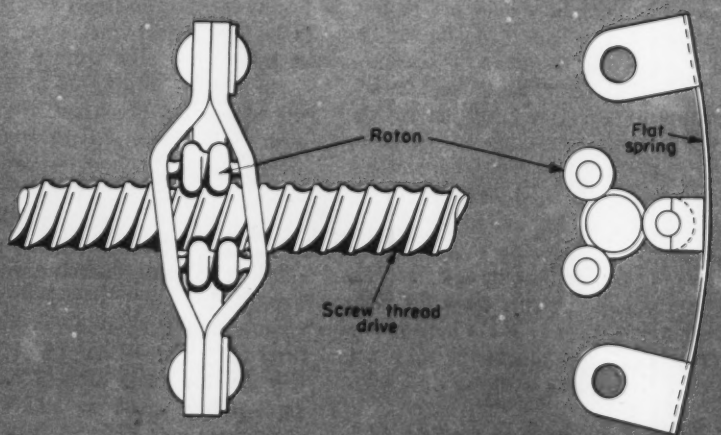
A patent case that comes to court is tried before a federal judge. If an engineer is the expert for the plaintiff, he will expect the expert to help him prove that the defendant has infringed a patent in which the plaintiff claims a sueable interest. The defendant may claim no infringement, or claim that the patent is invalid or admit his guilt and offer a settlement. The case will likely be a borderline one in which a fine line of engineering judgment must be drawn. The engineer experts seldom disagree in principle but frequently do in degree. The expert's job is to educate a judge in a short time in a field that is strange to the judge. He may break into the questioning to ask the expert to explain some difficult point in detail. That is a rare opportunity for the engineer to do his most effective work, for the judge will believe the expert who seems to know the most about the subject.

Into this battle of wits the expert must not go only partially armed. If he is an expert in capacitor motors he must not assume he will need little preparation on shaded-pole motors. If he has written a book or published technical papers, he may expect his opponent to introduce them if he can use them in any way to discredit the testimony. The expert is laying his reputation on the line to be sniped at by shrewd men willing to ruin it.

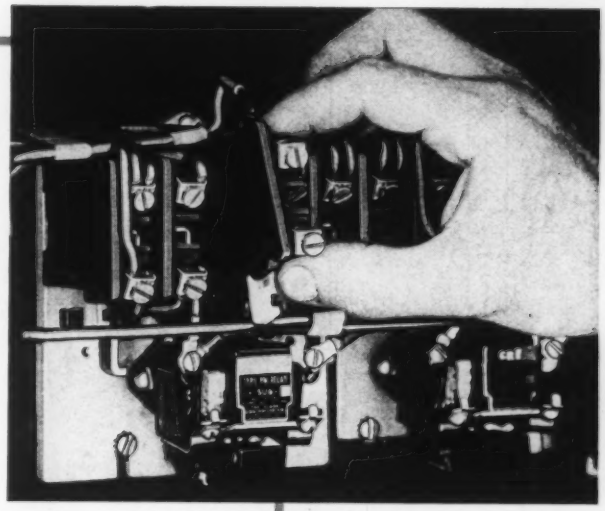
He will be working on a per-diem basis. His day will start with breakfast at six, discussion of yesterday's testimony until nine-thirty. He will be giving or listening to testimony until twelve, with luncheon and recapitulation until two, giving or listening to testimony until four, debating the significance of the testimony until nine with dinner eaten but hardly noticed, reading aloud and debating the court stenographer's transcript until twelve, and then trying to quiet his mind for a little sleep before six. There will be no eight-hour day for him, and he will be happier if he never figures how much he makes per hour. This is a short-term war, and if an engineer is temperamentally fitted for it, he will thrive on it. If not, he will vow to stay out of it forevermore and leave the witness chair to those who like it.

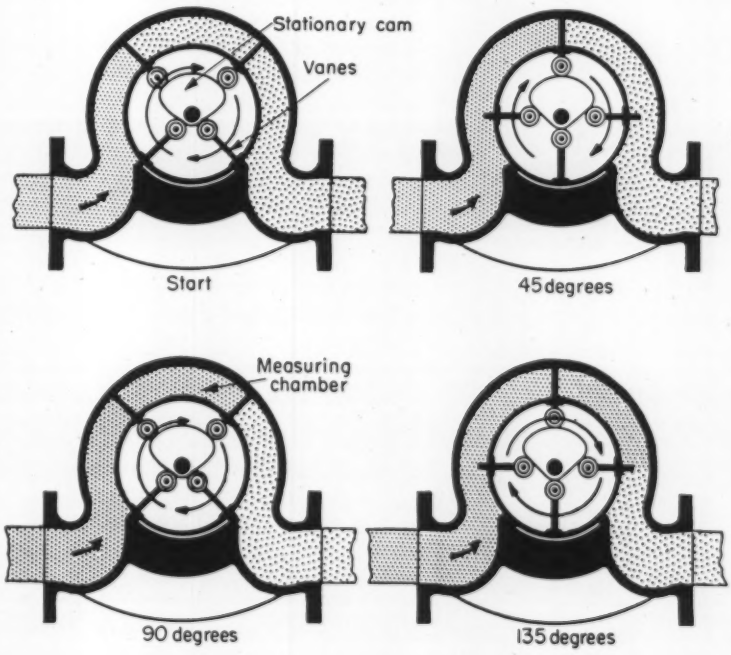
scanning the field for Ideas

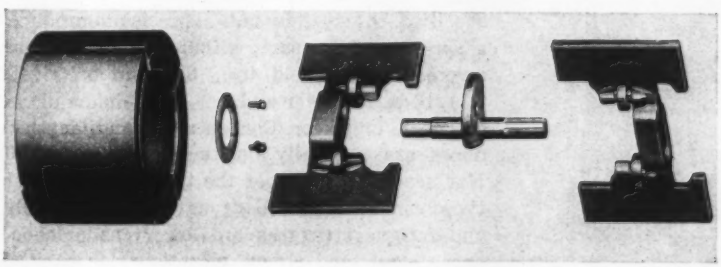
ANTIFRICTION NUT ASSEMBLY for power screw drives employs novel modified roller-bearing construction for conversion of rotary to linear motion. These bearings, which are of a ridged design and are tradenamed Rotons, were developed by the Anderson Co. Basically the nut assembly is composed of three bearings mounted between two stampings in an axially staggered relationship to accommodate the screw-thread lead. A flat spring presses against one of the bearings to keep the nut assembly tightly engaged. The design can be applied on solid or flexible shafts, employing a special thread form.



BUILDING-BLOCK CONSTRUCTION of electrical control devices simplifies disassembly and repair of complex units. In a design used by Clark Controller for multiple-pole relay units, each pair of contacts is mounted in a separate melamine plastic block that in turn is attached to the relay base by one screw. Only two wires need be disconnected and one screw removed to make a pole change without disturbing other poles or their wiring.







ACCURATE METERING of liquids is accomplished by a rotary positive-displacement measuring mechanism developed by A. O. Smith Corp. The basic mechanism consists of a free-running balanced rotor with four symmetrical vanes. As rotor revolves around a central shaft, the vanes, which are constructed in pairs, are caused to shuttle in and out by a stationary cam. In so doing the vanes move along with the fluid stream, dividing it into precisely measured segments of equal volume. Four times the volume of one measuring chamber passes through the meter for each complete revolution.

How To Select and Apply

SMALL RIVETS

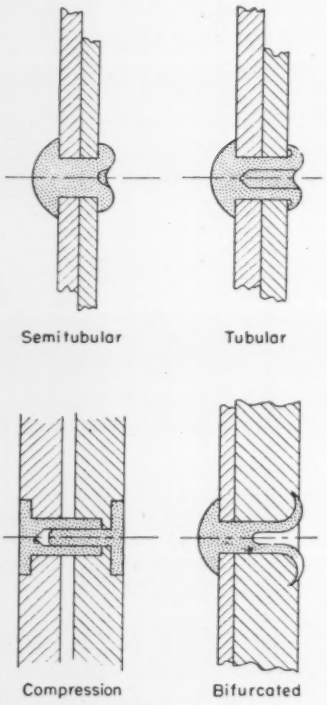
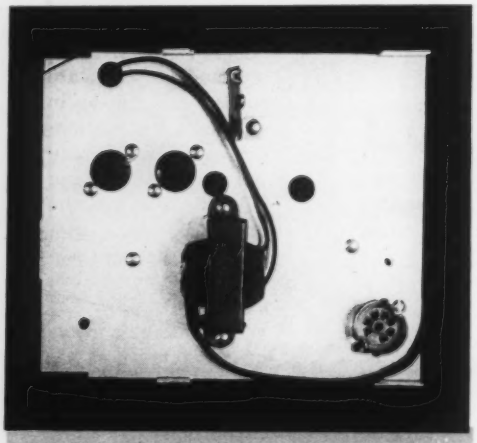


Fig. 1—Clinched rivets. Semitubular types are usually roll-set; tubular types star-set. Bifurcated forms are clinched against a solid die that turns back the legs and forms them tight against the surface of the assembly.



Tube sockets on radio, TV, and instrument chassis represent one of the larger applications of small rivets.

OF THE many fasteners and fastening methods available to the designer, few offer advantages of high-speed assembly and low cost comparable to the so-called tubular-type small rivets. Being cold formed, they can be made in large volume with high-speed heading machines. Being small and compact, they can be fed to the riveting machine with automatic feeders. And being of tubular design, they can be set with lightweight bench-mounted equipment at high rates of production.

It is this latter advantage that interests most manufacturers of products made in large volume. Even manually operated riveting machines are equipped with automatic hoppers, so that production rates often reach several hundred assemblies per hour. Usually it is the problem of feeding and positioning the work that limits production, not the capacity of the machine. But ingenious jigs and positioning fixtures are substantially increasing speeds of assembly, and today most automatic machines are being equipped with dual heads to keep pace with the flow of parts to the assembly stations. It is necessary only to check machine cycling times to determine potential rates of production.

In fact, it is almost solely on the basis of low cost and high production that small rivets are specified. A rivet is not a precision product like a screw-machine part; although tolerances on diameter can be held to $\pm$0.001-in. on rivets up to 1/16-in. diameter and to $\pm$0.003-in. on diameters of 1/4-in. or larger. Concentricity and length tolerances are generally on the order of $\pm$0.005-in. Nor are small rivets of the tubular or semitubular type considered high-strength fasteners. Tensile and fatigue strengths are low; tensile loads pull out the set, and severe vibrations loosen it. Even compressive and shear strengths, although better than those of some solid fasteners because of the

for high production jobs

By T. C. Buchanan
The Milford Rivet & Machine Co.
Milford, Conn.

forged grain structure of the rivet, are not substantially higher than many.

Then, too, riveted joints are neither watertight nor airtight, although they can be made so by the application of a sealing compound. Nor can the part, once riveted, be easily disassembled for maintenance. This limits application in some subassemblies and products. So, in the final analysis, cost is the primary factor influencing specification.

Naturally, this is over-simplification. Rivets, just as do other fasteners, have unique and individual advantages. They can be assembled by unskilled help; they can be made of a wide variety of materials and alloys; they can be designed to perform other functions in addition to assembly, such as acting as electrical contacts, pivots, or cam followers. They are also ideal for joining plastic sheet, fabrics, wood, and other nonmetallic materials to each other or to metal, since in full tubular or bifurcated form the rivet makes its own hole.

It is for all these reasons that small rivets are being used in the mass-production industries. The automotive industry is, perhaps, the most extensive user of small rivets. In this industry, they are used to join door frame assemblies, fasten fan blades to hubs, assemble clock, radio, lamp, medallion, and other component elements, attach brake linings to drums, assemble fabric to seat and body sections, and for many other assembly jobs.

Another large volume user is the appliance industry, in which both tubular and semitubular rivets are employed to fasten bimetallic thermostatic elements to bases, join heater assemblies and mounting brackets to toasters, fasten tube sockets to radio and TV chassis, and join molded or die-cast products to main assemblies, with the rivet being used as an insert in the plastic or cast part.

These are simply representative applications. To

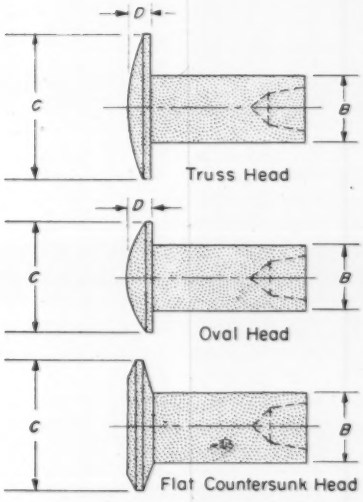


Fig. 2 — Semitubular rivets. Nominal dimensions are given in Table 1.

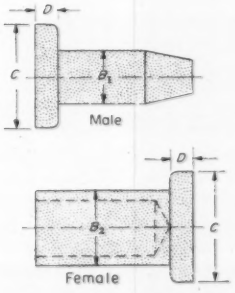


Fig. 3—Compression rivets, developed for cutlery. Nominal dimensions are given in Table 2.

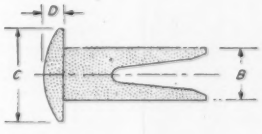


Fig. 4—Bifurcated rivet. Nominal dimensions are given in Table 3.

them must be added uses in air conditioning and refrigeration equipment, in electrical devices and lighting equipment, in commercial and military hardware, in toys and games—in fact, in any lightly loaded structure that is made in high volumes.

Types of Small Rivets: The conventional solid rivet, although widely used, does not as a rule lend itself well to high-speed assembly techniques. Practically speaking, there are five basic types of small high-production rivets: tubular, semitubular, bifurcated, compression, and special solid or tubular types. Some of these are illustrated in Fig. 1. Because it is difficult to determine the dividing line between special rivets and special cold-formed parts, the latter types will be referred to only briefly.

SEMITUBULAR RIVETS, Fig. 2 and Table 1, normally have a hole depth, measured along the wall, that does not exceed the shank diameter. This hole may be extruded or drilled, depending on rivet size and capacity of the manufacturer's forming equipment. A definite limiting factor is the type of rivet material, some of the high-strength steel and nickel alloys being difficult to extrude.

Actually, the principal differences between a drilled and an extruded unit are strength and shape of hole. For all practical purposes, however,

Small Rivet Tipsheet

1. Use standard rivet sizes, considering "specials" only when standard rivets are impractical.
2. Specify the softest material possible for rivets, consistent with strength requirements. The higher the strength and the greater the amounts of alloying elements, the more difficult the rivet will be to form and to clinch.
3. If the materials in the parts to be joined are thin or soft, consider bifurcated or full-tubular rivets that can form their own holes as they are driven, rather than semitubular or compression types for which holes must be punched or drilled.
4. Use a cap or washer under the clinch to prevent damage to brittle materials.
5. The shorter the rivet, the less the tendency for it to buckle when clinched. Therefore, specify rivets of minimum length having sufficient excess material for the clinch. See Tables 1 and 3 for recommended clinch allowances.
6. Use star-set clinch on soft materials or for any assembly that may have to be disassembled for repair or maintenance. The clinch can be knocked out more easily with a hammer and punch if a star-set, rather than a roll-set, clinch is specified.
7. Consider tool wear before deciding on rivet size, type, and material, or on assembly tolerances. The heavier the rivet, the bigger must be the riveting machine and the more wear there is on the tools. Generally the tighter the clinch, the more wear there is on the tools. Still, do not materially sacrifice joint efficiency for production economy.
8. Provide sufficient distance between the rivet and the edge of the work. The actual amount depends largely on the size of the rivet being used, which in turn determines the size of the jaws. If there is no side that may interfere with the jaws, only an amount equal to half of the bottom diameter of the jaws is sufficient.
9. If side wall interference may be encountered, minimum spacing equal to half of the maximum open diameter of the jaws is necessary, plus nominal clearance. For a ⅛-in. oval-head rivet, maximum open jaw diameter is on the order of 0.859 in.; for a ¼-in. oval-head rivet, it is 1.025 in., Fig. 6.
10. If unequal thicknesses of metal are being joined, specify that the clinch is to be formed under the heavier member with the head above the thinner member.
11. Reverse that procedure if two nonmetallic materials are being fastened and one is inherently stronger than another, as for example, fabric and plastic. In this case, form the clinch under the stronger material. Use a washer or cap, if possible, to prevent tearing of the material and provide a foundation for a tight clinch.
12. Do not form the clinch on an inclined, round, or uneven surface. If either the head or the clinch will rest on other than a flat surface, level it off by a machining or forming operation.
13. Provide location holes or specify a locating surface on the assembly to simplify positioning of the work on the riveting machine. Space rivet holes equidistant from one another whenever possible to facilitate assembly when multiple rivets are to be set in the same workpiece. On circular members, place rivet holes on the same diameter to permit use of an indexing fixture.
14. Consider assembly progression, and do not specify a methods sequence that will cause tool interference as assembly progresses.
15. If clearances are close, remember that less space is required around the plunger pin than around the jaws, and put the rivet head in the section with the greatest clearance. Consider the effect of interference from angular sections, and the depth of channel members on the design of the riveting tools.
16. If spacing between members is necessary, consider a shoulder rivet or one with a tenon that will automatically position the parts being assembled.
17. Use a washer, a shoulder rivet, or an excessive clinch allowance if the rivet is to act as a pivot shaft as well as a fastener.

Table 1—Semitubular Rivets

—Nominal Rivet Dimensions, Fig. 2—			Assembly Data, Fig. 5	
Body diam *B*	Head diam *C*	Head thickness *D*	Recommended hole diam	Max clinch allowance
		Oval head		
0.061	0.109	0.017	0.064	0.040
0.089	0.147	0.023	0.093	0.060
0.099	0.187	0.029	0.104	0.068
0.123	0.218	0.034	0.128	0.084
0.146	0.234	0.040	0.154	0.100
0.188	0.312	0.060	....	....
0.217	0.437	0.068	....	....
0.252	0.500	0.078	....	....
0.310	0.562	0.093	....	....
		Truss head		
0.061	0.125	0.017	0.064	0.040
0.089	0.187	0.023	0.093	0.060
0.123	0.281	0.034	0.128	0.068
0.146	0.312	0.040	0.154	0.084
0.188	0.375	0.060	....	....
		Flat countersunk head		
0.123	0.250	0.034	0.128	0.084
0.146	0.296	0.040	0.154	0.100
0.188	0.359	0.060	....	....
0.252	0.468	0.078	....	....
		Large flat countersunk head		
0.146	0.359	0.040	0.128	0.084
0.188	0.468	0.060	0.154	0.100

All dimensions are in inches. Rivet length is measured from the underside of the head. The hole depth to point of apex shall not be greater than shank length. Because the heads of these rivets are not machined or trimmed the circumference may be somewhat irregular and edges may be rounded or flat.

the strength difference is insignificant. So, for that matter, is the difference in hole shape. Although some taper must be allowed on an extruded type to strip the rivet off the extruding pin, it can be so small that the walls are nearly parallel.

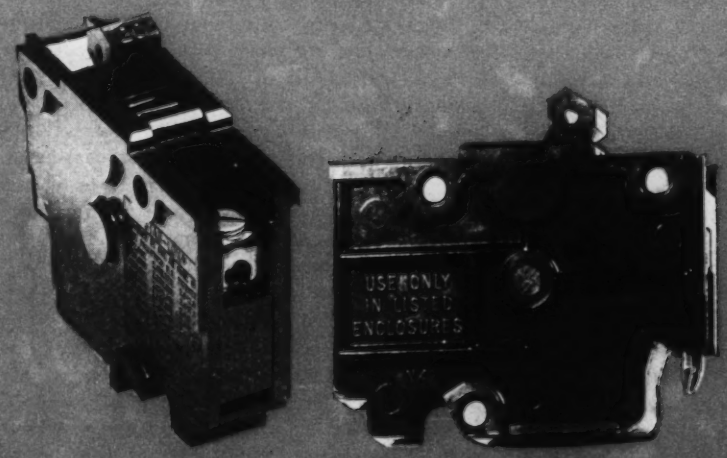
But there is a significant point about a semitubular rivet that does not apply to a full tubular type: when the rivet is clinched it becomes, in essence, a solid member. Its shear strength is equal to a solid rivet. So is its compressive strength. Thus, the semitubular or shallow-drilled rivet is used whenever full shear strength is necessary. It is, perhaps, the most widely applied of all the small rivet types.

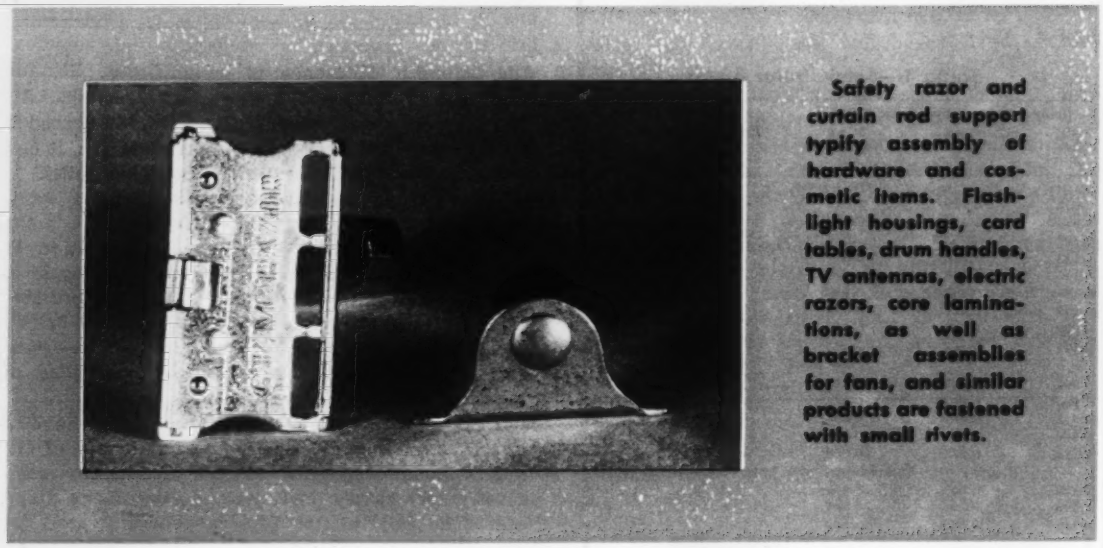
DEEP-DRILLED, FULL TUBULAR RIVETS have a cavity extending practically the full length of the shank. Some companies class as tubular any small rivet whose cavity depth exceeds the shank diameter. The full tubular type is generally used for assembling materials such as leather, plastic sheet, wood, fabric, or similar materials, since the rivet can pierce its own hole and the slug of material can be compressed inside the cavity.

COMPRESSION RIVETS, Fig. 3 and Table 2, are formed of two members: A solid or blank rivet

Approximately 20 million rivets per year are used for assembly of this type of circuit breaker unit by Federal Pacific Electric Co. A problem resulted from the operation of riveting on automatic machines having a preset mandrel height, for the molded parts varied in overall thickness by as much as 0.015-in. This variation would have been insignificant in joining of metal parts; with thermosetting plastic, it made a difference between a loose or a tight assembly, or with a closer setting, between a tight and a cracked assembly. A further requirement was the need for easy removal of these rivets, should the breaker fail to meet calibration requirements and have to be taken apart.

Star-set riveting as exemplified provided the answer. This form of riveting gave adequate strength, with the split segments of the rivet providing tight assembly; the segments are weak enough to curl more or less during riveting without cracking the material with excessive thickness of molded parts. It also permits the rivet to be pushed out by means of a pin exerting axial force at the center of the peened over rivet section. The split section curls in and allows the rivet to be forced out of the molded parts. Thus, the breaker can, if necessary, be dismantled for calibration or repair.





Safety razor and curtain rod support typify assembly of hardware and cosmetic items. Flashlight housings, card tables, drum handles, TV antennas, electric razors, core laminations, as well as bracket assemblies for fans, and similar products are fastened with small rivets.

Table 2—Compression Rivets

Nominal Rivet Dimensions, Fig. 3				
Head diam C	Head thickness D	Body diam — Male B_1	Body diam — Female B_2	Expanded diam
0.250	0.044	0.125	0.151	0.172
0.312	0.044	0.125	0.151	0.172
0.343	0.044	0.125	0.151	0.172
0.375	0.044	0.125	0.151	0.172
0.312	0.050	0.144	0.195	0.216
0.343	0.050	0.144	0.195	0.216
0.375	0.050	0.144	0.195	0.216
0.437	0.050	0.144	0.195	0.216

All dimensions are in inches. Expanded diameters are subject to wide variation due to the tolerances of the solid and tubular rivets. Hole diameters should be checked carefully before assembly. Rivet length is measured from the under side of the head. The hole depth to point of apex shall not be greater than shank length.

and a deep-drilled tubular member. The diameters of the solid shank and the drilled hole are selected so as to produce a compression or pressed fit when the parts are assembled. Most rivets of this type are made with trimmed heads, the trimming being done by a secondary turning or shearing operation after the rivets are formed. As a result, close concentricity tolerances can be held between the head and the shank, and both heads can have the same physical appearance, if desired, when assembled.

Compression rivets are widely used in the cutlery field because the heads fit evenly in counterbored holes and do not allow food or dirt particles to collect in the crevices. Also, since the rivet is assembled after holes have been drilled, and since the pressure for assembly can be closely controlled, they have little tendency to split wood or plastic compositions when used to join members made of such materials.

BIFURCATED RIVETS, or split types, Fig. 4 and Table 3, can be recognized by their "pronged" appearance. Sawed or punched in a secondary broaching or press operation, these fasteners are specified when the rivets are required to form their own holes in the members to be assembled. Since sawing or broaching does not distort the legs to the same extent as punching, bifurcated rivets made in this manner can be used for joining light-gage metals, or heavier sections of fiber, wood, or plastic. Punched types, on the other hand, are suitable for lighter piercing operations on nonmetallic materials.

Full tubular and bifurcated rivets are often used in combination with a cap. This acts as a washer to prevent the clinch from tearing through the material, gives the assembly a finished appearance on each end, and thus improves appearance and strength.

Rivets in the full-tubular or semitubular classification are made in oval head, truss head, or countersunk types, Fig. 2 and Table 1. Bifurcated rivets also are available in these three general head types, although oval head designs are far more common, Fig. 4 and Table 3.

SPECIAL RIVETS are tubular or solid, cold-formed members that are made with any of a variety of special features such as: tenon or shoulder to simplify location and assembly; fluted or knurled shanks, which are common when the rivet is to be used as an insert in a molding or casting; ornamental heads for cosmetic hardware or such products as fountain pens or pocket lighters; or special heads such as balls, cams, or hexagonal configurations to permit the rivet to perform a functional purpose in addition to acting as a fastener. Gage pointers for television channel selectors, electrical contacts, bearing pivots for gages and instruments, and similar uses are typical of the applications. However, as mentioned previously, it is often difficult to delineate between these and cold-formed products, so whether they belong in the "rivet" or special product category is difficult to say.

Materials for Small Rivets: Not every material can be formed by cold-working, but generally several compositions of every metallic material can be fabricated in this manner. Thus, small rivets can be produced in a wide range of alloys.

As might be expected, small rivets are most frequently made of steel, aluminum, or brass. Most fastener manufacturers consider these as standard, and list rivets made of other materials in the more or less special category. Still, it is not always necessary to change dies when going to special alloys, so which compositions are standard and which are special becomes of only theoretical interest in many instances.

Almost any soft grade of aluminum—1100, 3003, 2017, 2024, 5056, or even higher strength alloys—can be cold formed into rivets. But considering all alloys, more aluminum rivets are being produced today than ever before, not only because of forming characteristics but because of the increasing popularity of aluminum hardware, heating and cooking devices, business equipment, and toys, not to mention automotive assemblies and lighting fixtures.

Of the ferrous materials, low-carbon grades from about 1006 to 1010, medium-carbon grades from about 1013 to 1023, and high-carbon grades from 1023 to 1040 provide the strength and cost characteristics that are desirable in a rivet-fastener. The lower the carbon content, the easier the forming operation. Also, since rivets made of higher carbon content materials cannot readily be extruded and must be drilled, lower AISI grades are generally recommended.

Small rivets are also produced in all grades of brass, from rich, low alloys to 35-65 compositions. They are also made of copper, which is often specified by the electrical industry.

Low-melting alloys, such as lead or zinc, are seldom used for fasteners. Although they may be formed into rivet shapes, these are applied as fusible plugs for protecting liquid-filled products against excessive temperatures. Applications include low-pressure hydraulic reservoirs, radiators, heat-exchangers, and certain types of oil-bath electrical equipment, among other products.

Small rivets also can be made of many other types of materials, such as stainless Types 302 and 430, Monel, Inconel, and precious metals.

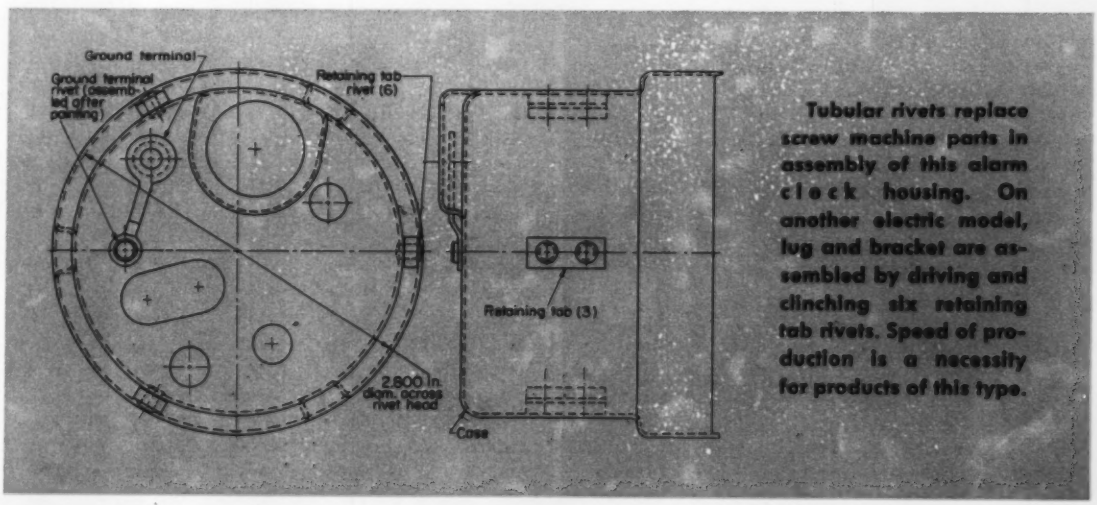
Plating of rivets is common—and relatively inexpensive. For example, zinc, copper, brass, nickel, or cadmium plating—or a chemical treatment such as Parkerizing—costs 20c per thousand for a 0.150-in. oval-head semitubular rivet with a 0.085-in. diameter, 5/8-in. long shank. For a rivet with a 0.375-in. oval-head and a 0.184-in. diameter shank 1.0 in. long the cost of such finishing would be $1.35 per thousand. Black japanning costs twice as much, as does bronze plating; colored japanning triples the plating price.

But the point is not price alone. It is simply that any plating or coating that can be applied to the base material generally can be obtained on a small rivet. This fact should be considered, however: the setting operation may be harmful to the finish. It may crack or mar the plate. If the rivet is used in a highly corrosive atmosphere, it may be rapidly attacked at the point of damage. Therefore, if high corrosion resistance is required,

Table 3—Bifurcated (Split) Rivets

Nominal Rivet Dimensions, Fig. 4			
Body diam *B*	Head diam *C*	Head thickness *D*	Max clinch allowance
0.091	0.148	0.022	0.091
0.080	0.156	0.022	0.080
0.119	0.218	0.034	0.119
0.119	0.312	0.055	0.119
0.146	0.312	0.046	0.146
0.146	0.375	0.062	0.146

All dimensions are in inches. Rivet length is measured from the under side of the head. Because the heads of these rivets are not machined or trimmed the circumference may be somewhat irregular and edges may be rounded or flat.



Tubular rivets replace screw machine parts in assembly of this alarm clock housing. On another electric model, lug and bracket are assembled by driving and clinching six retaining tab rivets. Speed of production is a necessity for products of this type.

it generally is better to specify a stainless steel or high nickel alloy as the base material.

How Rivets Are Clinched: Basically, two types of riveting machines can be used to set a rivet: manually operated or automatic models. Either type may be bench or floor mounted. Manually operated equipment consists of a floor treadle that actuates the machine; a hopper and track that supplies rivets, one at a time, to the upper jaws; and a plunger pin and die against which the rivet is clinched. Physical effort, multiplied by the levers connecting the treadle with the head, provides the necessary power. Automatic machines also are equipped with a floor lever, but this connects a single-revolution clutch to the driving shaft that in turn cycles the machine.

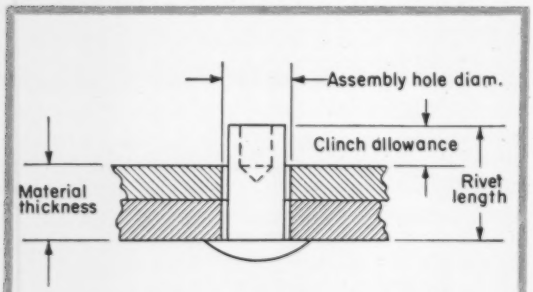


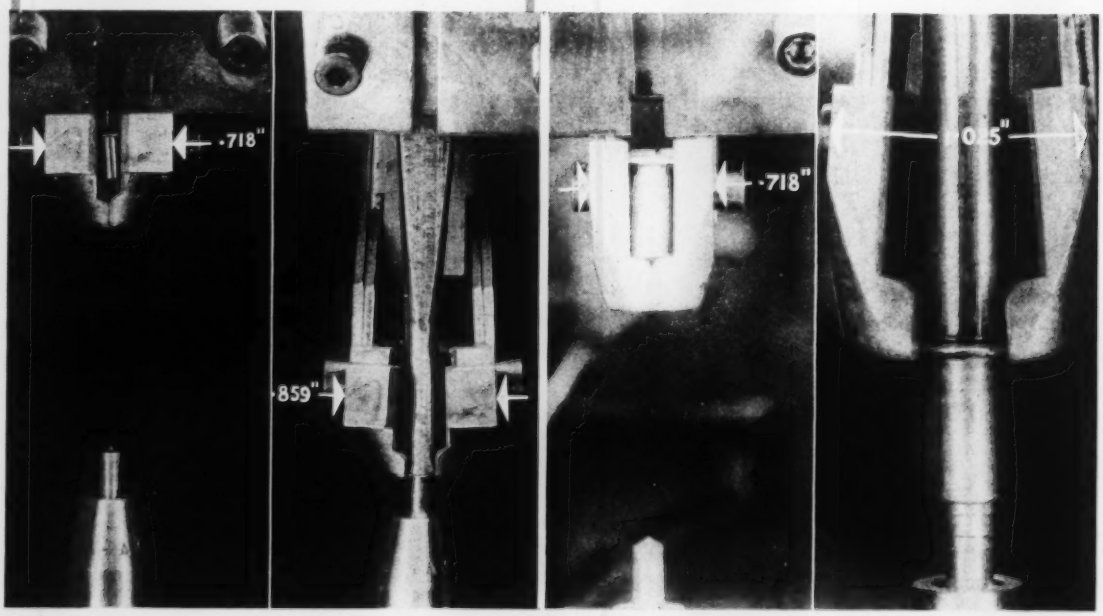
Fig. 5—Above—Rivet assembly details.

Fig. 6—Below—Why clearance is important. If insufficient clearance is provided between rivet centers and sides or walls of the assembly, the jaws of the riveting machine cannot be positioned to feed the fastener. For a typical ⅛-in. rivet (left), jaws measure 0.718-in. in the closed position, 0.859-in. when open. For a ¼-in. rivet (right) open jaw diameters are substantially larger.

Regardless of whether the equipment is manual or automatic, the principle of operation is the same. The rivet is fed from the hopper to a track that deposits it, shank down, in the center of the jaws. As the cycle proceeds, a driver descends and contacts the rivet head, forcing it downward past the point where the jaws come to a stop. This action pushes the rivet through the jaws and onto a spring-mounted plunger on the lower arm of the machine. With continued downward motion, the plunger pin retracts and guides the rivet through the work until it bottoms against the lower die and is clinched. When the driver and the jaws retract, the plunger pushes the rivet and the work off the die in the same manner as stripper pins in a forming die free the work in a pressing or drawing operation.

The anvils which form the clinch vary in design with the type of rivet and service requirements for the assembly. Semitubular or full-tubular rivets are usually roll or star-set. Roll-setting forms the rivet into an even, round clinch, either against the work, against the washer or, for a pivot pin or small shaft, in space. Star-setting cuts the rivet into six or eight even segments as the clinch is formed. Since less pressure is required to star-set than roll-set a rivet, this dictates its choice for relatively large diameter rivets with heavy walls. Obviously, too, a star-set clinch is less secure than a roll-set type, hence it is frequently specified for tubular rivets where high strength is generally less important than with a semitubular type.

Bifurcated rivets are usually set against a solid form that bends back the prongs and presses them into the work to provide a smooth clinch. If a washer or cap is employed, it is held in a



solid tip, and the tubular or bifurcated fastener is driven through the work and the hole in the cap and clinched against this member. Compression rivets, on the other hand, are not set as such, but are pressed together to form a tight fit; this is done by feeding the male member from the top arm of the riveting machine while holding the bottom or female half against a flat anvil.

Designing Riveted Assemblies: It is clear at this point that most—although not all—of the design problems connected with riveting revolve around the problem of designing for producibility. Since none of the small rivets discussed here are considered as high-strength, high-precision fasteners, nominal tolerances and allowances on hole diameter, clinch allowance, and rivet dimensions usually are satisfactory. But they are, nevertheless, important. If the hole in the workpiece is too small, the rivet will not enter the work or the plunger pin, which is approximately 2 per cent larger than the body of the rivet, will stick.

Recommended hole sizes for various types and sizes of rivets are given in Table 1. However, if the hole is not clean and straight, these sizes should be increased. Also, when two or more rivets are to be set in the same assembly, tolerances between centers should be taken into account when establishing hole dimensions. If molded or cast parts are to be joined, the tolerances of pieces produced in different molds or dies should be taken into account, since variations can present obstacles to high-production assembly.

Clinch allowances, Fig. 5, are no less important than hole clearance. These also are given in Tables 1 and 3. In addition, several rules of thumb have been developed for sizes not listed in the table: (1) maximum length of clinch for full-tubular and bifurcated rivets should be figured at 100 per cent of shank diameter; (2) maximum length of clinch for semitubular rivets should be 50 to 70 per cent of shank diameter to prevent buckling and insure a tight set. In this latter respect, if the rivet has been properly selected, the clinch allowance will be such that the tubular portion of the rivet will disappear in the clinch, and solid shank will remain to provide maximum strength.

These and other design hints are included in the accompanying Small Rivet Tipsheet. Some, such as those already discussed, are necessary to insure good joint efficiency. Others are required for speed of assembly. These latter recommendations can be modified, of course, but doing so generally results in lower rates of production.

Improving Thrust Bearing Performance

DESPITE the care exercised in the design and construction of cylindrical-roller thrust bearings, abnormal wear in the bore of the retainer can occur when these bearings are used on horizontal shafts. Reasons for this wear are: (1) inadequate lubrication because of normal pumping action of the thrust retainer, (2) poor finish on the shaft or sleeve on which the retainer operates, or (3) inadequate radial bearings which allow the shaft to run eccentrically.

Corrective procedures for the second and third mentioned causes are fairly obvious and are, of course, not directly related to the bearing design. There are, however, ways in which the bearing can be redesigned to correct or compensate for all of these three causes of malfunction, Fig. 1.

To eliminate lubrication difficulties, the roller retainer should be made of a good bearing material such as bronze rather than steel. Additionally, design should be such that retainer contact is on the OD rather than the ID, since normal lubricant pumping will provide better lubrication of the OD. Bearing retainer ID may then be relieved so that finish of the shaft or sleeve is of no consequence.

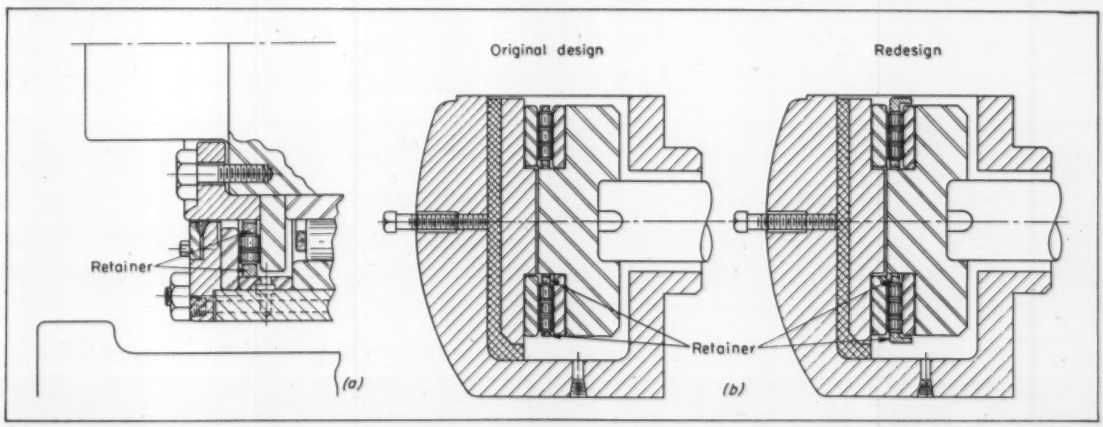


Fig. 1—Excessive wear of retainer bores on these roller thrust bearings was eliminated by using bronze retainers guided on the OD rather than the ID. At *a*, the guiding surface is the ID of an outer spacer sleeve. Outer surface of the rotating bearing plate serves as the retainer guide at *b*. Both methods take advantage of inherently better lubrication at the outer surface of the retainer.

Simple Perspective Drawings

A SIMPLE perspective view may be drawn without the use of vanishing points or extra gadgets. Take a simple rectangular block as an example.

First, arrange the top view at an angle that will expose two sides in relation to the picture plane, Fig. 1. Then determine a distance x in

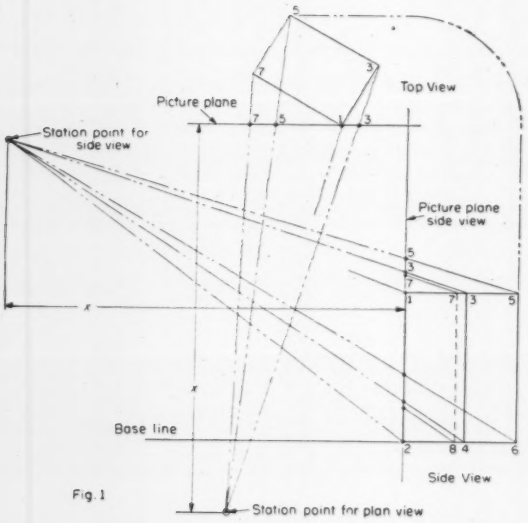


Fig. 1

front of the picture plane from which the object will be observed. This is the station point, representing the eye of the observer.

Next, draw a side view of the object, Fig. 1, in relation to the picture plane and locate the station point for the side view at distance x. This

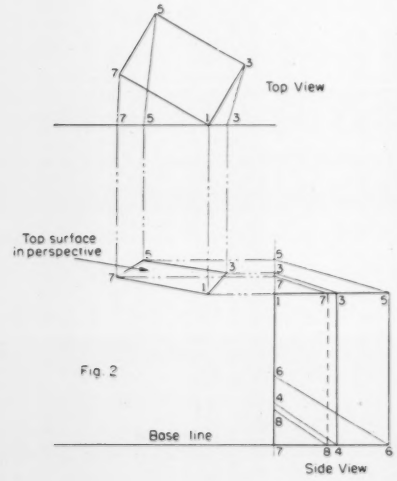


Fig. 2

point can be located at any height—usually high enough so the top surface can be seen. For convenience in this example, the corners of the block are numbered.

Each of these numbered points are projected onto the picture plane for that view, in line with the station point for that view. For example, the points locating the corners of the top view, 1, 3, 5 and 7 are projected as in Fig. 1.

From these points, draw lines at 90 deg to the picture plane, Fig. 2. The intersection of the lines from each of the numbered points determine the location of that point in the perspective view.

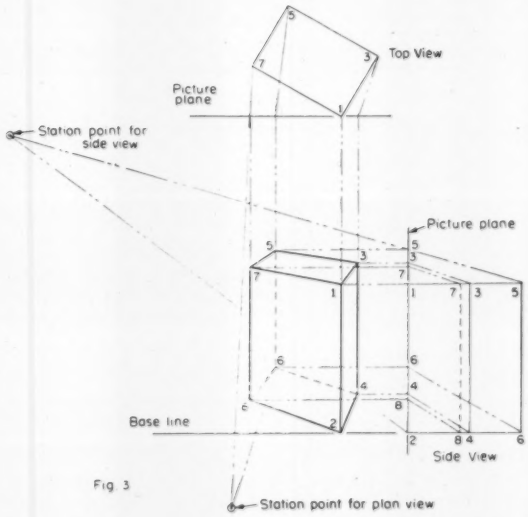


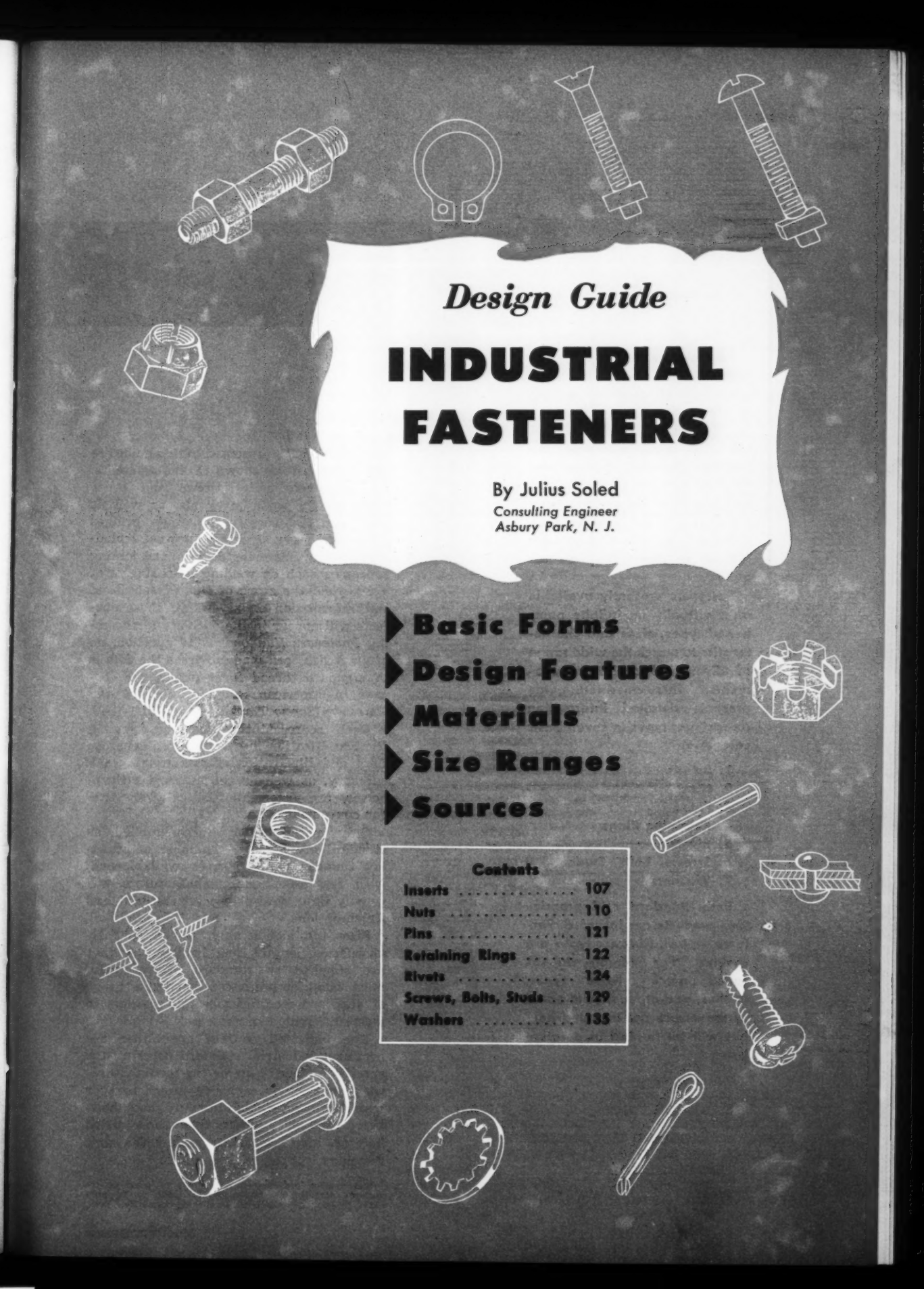
Fig. 3

For example, the top view, Fig. 2, is located by points 1, 3, 5 and 7.

The remaining points are projected in the same manner, Fig. 3, to complete the perspective view.—MERTON O. HODGES, *General Electric Co., Lynn, Mass.*

Constructing a Normal or Tangent

To construct an approximate normal to a curve, a mirror or a highly polished straightedge can be placed upon the curve at the point where the normal is to be drawn and then turned so the reflection and the curve on the paper appear to form a smooth continuous line. A line drawn along the edge of the mirror or straightedge will then be very nearly perpendicular or normal to the curve. An approximate tangent to the curve can then be drawn perpendicular to the normal.—LEROY PAYNE, *Lockheed Aircraft Corp., Burbank, Calif.*



Design Guide

INDUSTRIAL FASTENERS

By Julius Soled
Consulting Engineer
Asbury Park, N. J.

- **Basic Forms**
- **Design Features**
- **Materials**
- **Size Ranges**
- **Sources**

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A Design Guide to

Fastener selection and application are problems that reach into all areas of design. From individual part to final assembly many separate decisions are often required to meet the varying demands of production, performance and appearance. In some cases, a standard rivet or bolt will provide the solution. In others, a special locknut or insert may be required.

Fasteners presently available offer virtually an infinite number of types, sizes and characteristics to match the wide range of diversified design requirements. This classified guide presents detailed information on fastener types in seven basic categories:

1. **Inserts**
2. **Nuts**
3. **Pins**
4. **Retaining Rings**
5. **Rivets**
6. **Screws, Bolts, Studs**
7. **Washers**

Both standard and proprietary products are included. Perforce, not all fastener types are covered. For example, the so-called quick-release types, latches, and other special panel fasteners are not included here but will be treated in a future issue.

FASTENERS presented in this guide are classified as shown in the Contents. However, nails, screws and other fasteners for wood materials, as well as structural fasteners for buildings, bridges and other heavy structures are not included. Similarly, clamping devices, and joining processes such as welding, stitching, etc., are beyond the scope of this presentation. But information on several of these subjects will appear in the author's forthcoming *Fasteners Handbook*.* In addition, no attempt has been made to treat the details of standard thread forms which are covered in American Standard *Unified and American Screw* Threads—ASA B1.1-1949.

Each representative fastener type in the classification is covered by a separate item and illustration. Items within each category, as well as the categories themselves, are listed alphabetically by title for convenience.

Only materials that are supplied as standard are listed. A number of standard finishes are also made available and, with few exceptions, manufacturers will usually offer several special material and finish options.

Sizes, too, include only the nominal fastener sizes, lengths and body styles that are supplied as standard. Here again, most manufacturers can supply a range of standard modifications and specials to meet different requirements.

The indicated sources are either the pertinent industrial standard covering the specific fastener type or the manufacturer with primary or exclusive proprietary or manufacturing rights. In many cases, however, companies other than those listed here are also licensed to produce the same fasteners.

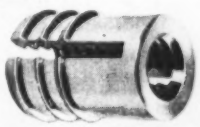
*Information presented in this guide is based on the author's forthcoming *Fasteners Handbook* to be published by Book Div., Reinhold Publishing Corp., New York.

INDUSTRIAL FASTENERS

INSERTS

The insert is basically a special form of nut designed to serve the function of a tapped hole in blind or open locations. It may be used to provide high-strength threads in soft materials where frequent assembly and removal of threaded fasteners are required, to provide a threaded hole with locking features, or to provide a thread anchor in materials where tapping is impractical. Comparable application characteristics are also offered in design by the various anchor, clinch and weld nuts.

Banc-Lok Insert



Form: Slotted, internally threaded self-locking insert with exterior annular fins or knurled surface. Insert is pressed into blind or open hole, causing slotted sections at blind end to bend inward. Entrance of threaded fastener expands slotted sections, driving fins or knurls into wall of hole to hold insert in place. Radial inward pressure of insert threads provides locking action.

Design Features: Reusable. Provides strong self-locking threads in blind holes in thin sections and soft materials. Locking action of insert is controlled by varying size of mounting hole. Does not mar part surface. Eliminates need for molded-in inserts. Can be adapted to high production machine assembly methods.

Materials: Brass, stainless steel and steel.

Sizes: No. 4-40 to ⅜-16 internal threads. Lengths from $\frac{3}{16}$ to $\frac{5}{16}$-in. Body styles include one, two or three fins, or knurled surface.

Source: Boots Aircraft Nut Corp., Norwalk, Conn.

Banc-Lok Tapped Holes

Form: Slotted, internally threaded self-locking insert with double-tapered sides. Insert is pressed into through hole in thin section, causing slotted blind ends to move inward. Entrance of threaded fastener expands slotted sections to wedge insert in place. Radial inward pressure produces locking torque on screw threads.

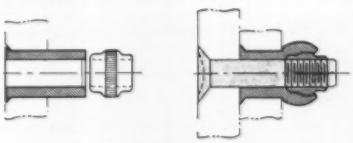
Design Features: Reusable. Can be installed with standard tools. Size of mounting hole determines locking torque of threads. Insert can accommodate thickness variation range of 0.015-in. Provides strong threaded hole in sheet materials too thin to tap.

Materials: Aluminum, brass, stainless steel and steel.

Sizes: No. 4-40 to ¼-20 internal threads. Grip lengths from 0.035 to 0.130-in. Standard heads are flat and countersunk.

Source: Boots Aircraft Nut Corp., Norwalk, Conn.

Blind Nut



Form: Two-piece nut-type insert assembly consisting of a flanged sleeve and threaded round expander nut. Sleeve is inserted in prepared hole and nut is driven into unflanged end and cinched in place. Expansion of end of sleeve locks the two members securely in part.

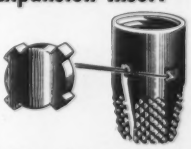
Design Features: Provides a high-strength blind fastener for machine and aircraft structures and related applications. Resists vibration. Can be used in collapsible panel materials since grip length is controlled. Provides flush mounting.

Material: Sleeve is modified stainless steel and expander nut is corrosion-resistant steel.

Sizes: No. 10 to ⅜-in., UNF threads, Class 3. Head style of sleeve is countersunk.

Source: Hi-Shear Rivet Tool Co., Torrance, Calif.

Dodge Expansion Insert



Form: Two-piece preassembled insert consisting of four-eared spreader member mounted in slotted internally threaded metal shield. External surface of slotted sections is knurled. After insert is mounted in hole, spreader member is forced outward in slots, expanding slotted end to drive knurls into hole wall.

Design Features: Torque and pull strength of insert is comparable to molded-in insert. Can be inserted manually or by machine. Internal threads are not injured by expansion operation; sides of slots carry forces. Shoulder in shield locks spreader in fully expanded position. Used primarily in die cast and plastic parts to serve function of conventional molded-in inserts.

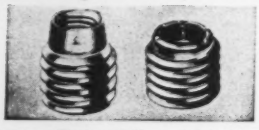
Materials: Brass.

Sizes: No. 4-40 to No. 10-32 in-

ternal threads. Thread lengths from $\frac{3}{16}$ to $\frac{3}{8}$ in.

Source: The Phelps Mfg. Co., Westport, Conn.

Esna Locking Insert



Form: Externally and internally threaded bushing. External threads are modified American National thread form which provides self-locking interference fit in tapped hole. Internal threads have either nylon locking collar (under 250 F) or all-metal locking device (over 250 F) for locking screw fasteners.

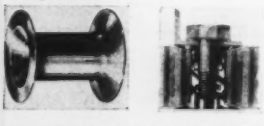
Design Features: Provides strong, wear-resistant tapped hole. Can be installed in any material with hardness less than Rockwell C-25 by tapping hole with standard Class 2 controlled-root tap. Internal threads accept AN bolt thread lengths. Insert develops full load strength of AN bolts in aluminum, magnesium and mild steel and increases load capacity of plastic materials. In assembly, action of external thread on socket threads provides equivalent of selective fit, sealing external threads against leakage and producing positive locking action that resists loosening effects of vibration and backing-out torque of bolt. Insert can be removed and reinserted.

Materials: Steel.

Sizes: No. 10-32 to $\frac{3}{8}$-24 internal threads, Class 3B.

Source: Elastic Stop Nut Corp. of America, Union, N. J.

Fasco Spacer



Form: Two-piece, internally threaded insert assembly consisting of a plug and tapped sleeve. Mating parts are mounted in drilled hole, using interference fit to assure tight assembly of parts and a positive aligned grip. Self-locking type has nylon insert in tapped sleeve to provide prevailing-torque locking action.

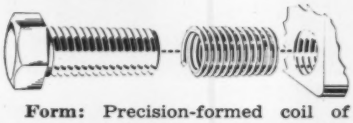
Design Features: Provides a strong, self-retaining tapped hole in lightweight panels or other fragile structures where fastening takeup must be limited to a specific grip length. Can be installed by hand or machine. Can be conveniently and permanently installed at subassembly.

Material: Aluminum.

Sizes: No. 6-32 to $\frac{1}{4}$-28 internal threads. Grip lengths from $\frac{3}{16}$ to $1\frac{1}{32}$-in. Head styles include flush, nonflush and countersunk.

Source: The Delron Co. Inc., South Gate, Calif.

Heli-Coil Insert



Form: Precision-formed coil of diamond-shaped wire. When seated in tapped hole, coil provides standard size 60 degree threads.

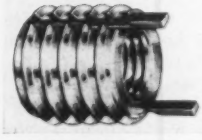
Design Features: Provides high-strength, permanent threads in soft materials or thin sections. Driving tang, which can be broken off, is located at bottom turn of coil to facilitate installation. Insert diameter is slightly oversize; when wound into properly tapped hole, coil locks in place and will withstand severe vibration loads without loosening. Simple construction of insert facilitates assembly.

Materials: Stainless steel wire with an ultimate tensile strength of about 200,000 psi.

Sizes: No. 4 to 1½ in.; NC, UNC, NF and UNF internal threads; Class 2B and 3B. Lengths from 1 to 3 diameters.

Source: Heli-Coil Corp., Danbury, Conn.

Keensert



Form: Internally and externally threaded insert designed to be mounted in tapped hole. Grooves in external thread surface admit pins which are pressed into base of tapped hole to hold insert in position.

Design Features: Provides strong, easily installed threaded hole in aluminum, magnesium, plastic and other material. Can be installed by hand in holes tapped with standard tools. Pin keys provide positive resistance to insert rotation when screw is tightened.

Materials: Passivated stainless steel, carbon steel and chrome-moly steel.

Size: No. 4 to 1 in.; Coarse and Fine internal threads. Body styles include closed and open ends.

Source: Newton Insert Co., Los Angeles.

Kelox Insert

Form: Two-piece insert assembly consisting of externally and internally threaded insert member and locking key ring. Projecting keys on surface of ring fit into mating axial grooves in upper external threads of insert. When ring is pressed into place after insert is screwed into tapped hole, keys cut through sufficient tapped threads to provide positive locking action.

Design Features: Insert can be installed and removed with standard tools. Tapped hole is not injured when insert is removed for replacement. Internal threads can be readily adapted to several screw locking devices. Permits use of minimum edge distance.

Materials: Carbon and alloy steels, stainless steels, brass, bronze and aluminum.

Sizes: No. 0 to 1 in.; Coarse and Fine internal threads.

Source: Fasteners Inc., New York.

Kwiko Insert

Form: Two-piece, self-locking panel insert assembly consisting of internally threaded insert and metal grommet. Insert is mounted in counterbored hole in panel and grommet forced in place. Screw driver slot is provided in end of insert for prevention of rotation when threaded fastener is being installed.

Design Features: Provides lightweight threaded blind hole that can carry load and prevent collapse of panel structure. No special installation tools required. Primarily used in honeycomb sandwich panels.

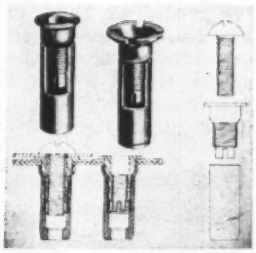
Materials: Aluminum.

Sizes: No. 8-32, No. 10-32 and $\frac{1}{4}$-28 internal threads. Lengths from $\frac{3}{16}$ to 1 in.

Source: Shur-Lok Corp., Fullerton, Calif.

Lok-Skru

Form: Two-piece, all-metal insert assembly consisting of internally threaded sleeve member and shouldered and headed insert element with internal and external threads. Insert element is pressed into drilled hole with head seated against part surface. Sleeve member is mounted like nut from back of part, using special tool. As sleeve is



tightened, it expands and flows over shouldered section of insert to lock insert in place.

Design Features: Provides a rugged, long-wearing, positively locked thread anchor for screw attachments in sheet-metal parts or thin sections. Can be adapted for high-speed assembly methods.

Materials: Steel or aluminum.

Sizes: No. 6 to No. 12, Coarse and Fine threads. Suitable for part thicknesses from 0.010 to 0.330-in. Insert head styles included flush, flat and countersunk.

Source: The Dill Mfg. Co., Cleveland.

Mid-Grip Locking Insert

Form: Precision-formed coil of 18-8 stainless steel diamond-snaped wire with one or two polygon-shaped constricting loops at center. When seated in tapped hole, coil provides standard 60-degree threads. Constricting loops at center produce locking action.

Design Features: Provides high-strength, permanent threads with built-in locking action. Resists extreme temperature variations and frequent assembly and disassembly. Insert diam is slightly oversize; when wound into properly tapped hole, coil locks in place and will withstand severe vibration loads without loosening. Reusable.

Materials: Stainless steel wire with ultimate tensile strength of 200,000 psi.

Sizes: No. 6 to ½-in.; NC, NF, UNC and UNF internal threads. Lengths from 1½ to 2 diameters.

Source: Heli-Coil Corp., Danbury, Conn.

My-T-Grip Insert

Form: Metal disk with threaded center hole. Insert is locked in position in suitable hole by swaging.

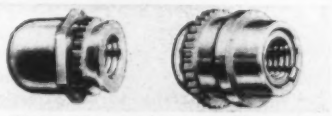
Design Features: Insert is locked in place by flow of part or disk material during assembly. Knurled edge of disk prevents turning. Can be installed close to edge without distortion of base material. Provides low-cost threaded hole in sheet metals or soft materials where tapping is impractical or undesirable.

Materials: Brass, steel, stainless steel and aluminum.

Sizes: No. 2-56 to ¼-20 internal threads. Body styles include several modified shapes.

Source: My-T-Grip Mfg. Co. Inc., New York.

Newton Cast Inserts



Form: Internally threaded insert assembly designed to be cast in soft metals or molded into plastics. Insert consists of internally threaded metal shell and removable inner sleeve with external threads for assembly in the shell and internal threads for screw attachments. Sleeve is held in shell by lock ring or key.

Design Features: Provides a strong replaceable threaded hole. Sleeves in key type can be readily varied to provide nonlocking or self-locking features. Assembly and removal of sleeves does not require special tools.

Material: Stainless steel.

Sizes: ¼-in. and other standard UNC and UNF threads, Class 2B. Body styles include flush and projecting types.

Source: Newton Insert Co., Los Angeles.

Nylok Threaded Insert

Form: Selflocking, internally and externally threaded insert. Insert is mounted in tapped hole. Radial nylon plug provides positive wedge locking action on both internal and external threads.

Design Features: Reusable. Eliminates need for counterboring, special tapping and secondary operations. Requires only standard screw driver for insertion or removal in hole drilled and tapped with standard tools. Nylon plug sets up lateral thrust on both internal and external threads, smoothly wedging mating threads together on both tapped member and screw without galling, thread distortion, or mutilation of mating threads. Useful temperature range under average conditions is −70 to 250 F. Used principally in nonferrous forgings, castings and extrusions to provide strong removable, tapped hole, or in applications where bolt removal and replacement may be frequent.

Materials: Low-carbon steel.

Sizes: No. 8-32 to ⅜-24; class 3B internal threads.

Source: The Nylok Corp., Elmira Heights, N. Y.

Rivnut

Form: One-piece tubular blind rivet with internal threads. Force exerted by pull-up stud inserted in threaded section causes shank to expand at its center and lock rivet in place.

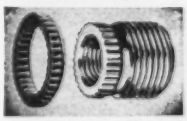
Design Features: Serves function of blind nut plate. At least 6 clean threads are provided for fastener attachment. Wide bearing surface of rivet forms liquid-tight seal. Finish of enameled or plated surfaces is not marred when rivet is installed.

Materials: Aluminum, steel, stainless steel and brass.

Sizes: No. 4-40 to $\frac{7}{16}$-18 internal threads. Wide range of standard grip lengths. Head styles include flat or countersunk.

Source: The B. F. Goodrich Co., Rivnut Div., Akron.

Rosan Threaded Insert



Form: Two-piece all metal insert assembly consisting of internally and externally threaded insert and serrated locking ring. Insert is mounted in counterbored tapped hole and locked in position by locking ring. Serrated teeth on ring ID engage mating teeth on collar of insert while teeth on ring OD broach their way into counterbored surface when ring is driven or pressed into place.

Design Features: Requires only Class 3 tapped hole for installation. External threads on insert have special pitch diameter which produces interference locking fit in tapped hole. Resists loosening effect of vibration, high stress and temperature change. Insert installation does not distort or stress

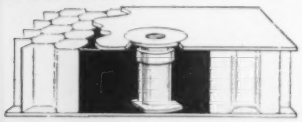
part material, and does not require special tools. Can provide effective sealing against hydraulic or pneumatic pressure. Used to provide durable steel tapped hole in all types of materials.

Materials: Insert is steel; locking ring is case-hardened low-carbon steel.

Sizes: No. 4 to 1 in.; Coarse and Fine internal threads. Body styles include several modified forms of basic insert.

Source: Rosan Inc., Newport Beach, Calif.

Shur-Lok Insert



Form: Self-locking internally threaded panel insert. Insert is mounted in hole drilled in one face of panel and molded in place against opposite interior wall. Locking action is provided by boss section near blind end.

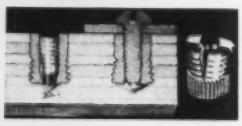
Design Features: Provides strong threaded blind hole in built-up lightweight panel structures. Locking action meets AN-N-5 requirements. Used primarily in sandwich type panels.

Materials: Aluminum, steel and stainless steel.

Sizes: No. 8-32, No. 10-32, and ½-28 internal threads. Grip lengths from ¼ to 2 in.

Source: Shur-Lok Corp., Fullerton, Calif.

Southco Anchor Nut



Form: Slotted, internally threaded self-locking insert. External surface is barbed at slotted end and serrated at other end. Insert is driven into hole and expanded, engaging barbs and serrations with hole wall to hold insert securely in place. Threads provide positive gripping action to lock screw attachments in place.

Design Features: Provides strong, permanent threaded hole for machine screws. Part surface is not marred during installation. Used to provide permanent tapped hole in soft material where frequent assembly or disassembly of threaded members may be necessary.

Materials: Steel.

Sizes: No. 6 to $\frac{5}{16}$-in.; Fine and Coarse internal threads. Lengths vary with thread size.

Source: South Chester Corp., Southco Div., Lester, Pa.

Southco Insert

Form: Internally threaded insert with knurled external surface. Insert is pressed or driven into drilled or molded hole. Spiral knurls grip wall of hole to hold insert firmly in place.

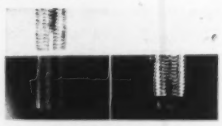
Design Features: Provides a strong threaded hole in blind or open locations in soft or fragile materials. Design of spiral knurls resists torque and pull-out forces.

Material: Steel.

Sizes: No. 1 to $\frac{5}{16}$-in.; NC and NF threads; Class 2.

Source: Southco Div., South Chester Corp., Lester, Pa.

Tap-Lok Insert



Form: Internally and externally threaded bushing. Internal threads accommodate standard screw sizes; external threads are self tapping for driving into drilled or cored hole.

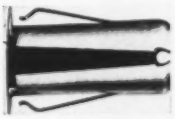
Design Features: Provides strong working thread surface. Self-tapping feature eliminates need for separate tapping operation in assembly. Insert resists loosening effect of vibration. Used to increase shear strength of threaded holes in low-strength materials such as plastic, aluminum, magnesium and cast iron.

Materials: Brass or case-hardened steel.

Sizes: No. 4 to ½-in. internal threads, depending on material.

Source: Groov-Pin Corp., Ridgefield, N. J.

Tubular Clips



Form: One piece, all-metal locking insert for unthreaded parts. Tubular clip is inserted into prepared hole and held in position by cam-like prongs. Unthreaded stud or rivet is pushed into clip. Turned-in end of clip bites into fastener surface under spring action to provide secure lock.

Design Features: Adaptable to high-speed assembly methods. Ideally suited to use in blind locations. Used to provide low-cost locking blind fastener for unthreaded parts.

Material: Heat-treated spring steel.

Sizes: ⅛ to ¼-in. diameter studs.

Source: Tinnerman Products Inc., Cleveland.

Weg Insert

Form: Internally and externally threaded insert designed to be mounted in tapped hole. External thread surface is grooved to admit locking pins which are driven into base of tapped hole to lock insert.

Design Features: Provides strong, six-thread fastener attachment. Increases thread pull-out strength and wear resistance in soft materials. Anchor strength limited only by strength of part material. When cast in molded plastic, external grooves automatically provide locking device. Sizes under ¼-in. can be installed with screwdriver.

Materials: Carbon or stainless steel.

Sizes: No. 0 to 1 in., Coarse and Fine internal threads; Class 2.

Source: Roylyn Inc., Glendale, Calif.

NUTS

Of the various fastener products, nuts offer the most diversified range of characteristics, sizes, and types. Basically, they can perhaps be best classified into two principal types: nonlocking and locking. Properly tightened, a nonlocking nut will usually not loosen providing sufficient pressure is maintained between the threads, at the nut, and at the bolt-head seat. Under vibration or impact, where the pressure fluctuates, loosening may occur unless some locking device is employed. Locknuts offer two principal types of locking action. Prevailing-torque (sometimes called self-locking) locknuts provide a continuous gripping

action when the locking device is engaged with bolt thread. They can usually be employed as either a seated locknut or a stop nut. Free spinning, or load-locking, locknuts require a base load to develop locking action. They can usually be employed only as a seated locknut, although some types, which incorporate a load-locking member, can also be used as stop or adjusting nuts.

NONLOCKING NUTS

Allenut

Form: All-metal, dual-purpose nut that can be used as internal-wrenching nut or thread insert. One end has internal 12-point socket for wrench tightening, while other end is internally threaded. External knurled collar permits anchoring of nut in counterbored hole for use as insert.

Design Features: Provides hardened thread insert in castings or soft materials, or compact wrenching nut for machine assemblies. Can be pressed or molded into preassembled parts. Length of thread engagement is same as for conventional medium-weight nut. Can be readily removed and replaced in insert application.

Materials: Hardened and tempered alloy steel.

Sizes: No. 4 to 1 in.; NC and NF threads.

Source: The Allen Mfg. Co., Hartford, Conn.

Anchor (Plate) Nuts

Form: Nut with lug projections for permanent mounting to work. Nut and lugs may be integral, or cage-type construction may be employed with nut rigidly attached or floating. Nut is mounted by welding, riveting or other methods.

Design Features: Provides a permanent nut attachment for assembly of threaded fastener elements in blind or open locations. Shape of lugs can be modified to fit application. Eliminates danger of loose nut becoming lodged in mechanism.

Materials: Steel, corrosion-resistant steel and aluminum.

Sizes: No. 4 to ⅝-in.; Coarse and Fine threads, Class 2B and 3B. Ranges vary with manufacturer. Nut types include nonlocking and self-locking. Body styles include fixed and floating one lug, two lug, triangular, gang and others.

Source: Produced by several manufacturers. Illustrations, courtesy (Boots) Boots Aircraft Nut Corp., Norwalk, Conn.; (Esna) Elastic Stop Nut Corp. of America, Union, N. J.; (Kaylock) Kaylock Div., Kaynar Co., Los Angeles; (Nutt-Shel) Nutt-Shel Co., Glendale, Calif.

Cap (Acorn) Nuts

Form: Hexagon nut with crown cap.

Design Features: Provides sealing protection for projecting threaded parts. Gives a neat, finished appearance.

Materials: Steel, brass, zinc, aluminum and other materials.

Sizes: No. 6 to 1¼ in.; Coarse and Fine threads.

Source: SAE Recommended Practice, 1956 *SAE Handbook.*

Captive Nut

Form: One-piece, all-metal self-clinching nut. Nut has hex head and round shank of reduced diameter with groove under head. Shank is pressed into hole and head is seated against part surface. Cold flow of material into grooved section of shank locks nut in place.

Design Features: Provides a strong flush-mounted tapped hole in aluminum or brass sheet-metal parts. Can be assembled from one side in blind locations. Suitable for material thickness down to 0.040-in.

Materials: Passivated stainless steel.

Sizes: All standard threads.

Source: National Co. Inc., Malden, Mass.

Castle (Castellated) Nuts

Form: Hexagon nut with a cylindrical crown through which slots are milled. Cotter pin or safety wire inserted in drilled hole in bolt can be used to lock nut in place.

Design Features: General-purpose nut that can be readily adapted to provide locking features. Provides solid hexagon base, since slots are located in crown.

Materials: Steel, brass, aluminum and other standard materials.

Sizes: ¼ to 1½-in., Coarse and Fine threads; Class 2B.

Source: American Standard *Square and Hexagon Bolts and Nuts* —ASA B18.2-1955.

Clinch Nuts

Form: Threaded nut with pilot-type projection on bottom face. Nut is seated on sheet-metal part or thin section with pilot mounted in prepared hole. End of pilot is clinched to lock nut in place.

Design Features: Provides a permanently attached nut for assembly of threaded fasteners in blind or open locations. Adaptable to high-speed assembly methods. Can be used with metals difficult to weld, with sheet-metal parts or materials where tapping is impractical, or with prefinished parts.

Materials: Steel, brass and aluminum.

Sizes: Most standard nut sizes; Coarse and Fine threads. Body styles include square, hex, round, floating and others.

Source: Produced by several manufacturers. Illustrations, courtesy (Gripco) Grip Nut Co., Chicago; (Mount Clemens) Mount Clemens Metal Products Co., Detroit.

Gripco Weld Nut

Form: All-metal hex-body nut with three weld projections and pilot collar on bottom surface. Nut is projection welded to part surface.

Design Features: Provides a permanent nut attachment for steel stampings or other parts where threaded hole is impractical. Pilot collar design facilitates assembly in prepared hole without special jigs. Collar prevents fouling of threads by weld spatter.

Materials: Mild steel.

Sizes: No. 8 to ⅝-in.; Coarse and Fine threads. Body styles include countersunk seat as well as locking

and nonlocking types.

Source: Grip Nut Co., Chicago.

Hexagon Nuts

Regular

Thick

Form: One-piece, standard threaded nut.

Design Features: General-purpose nut. Finished series is designed for average use. Heavy series is thicker and wider and is suitable for use with heavy loads and large bolt clearances.

Materials: Steel, brass, aluminum, sintered brass, nylon and other standard materials.

Sizes: ¼ to 4 in.; Coarse, Fine and 8-thread series; Class 2B. Body styles include regular, regular semi-finished, finished, heavy and heavy semifinished.

Source: American Standard *Square and Hexagon Bolts and Nuts* —ASA B18.2-1955.

Jam Nuts

Form: Thin standard hexagon nut.

Design Features: Used primarily on bolts subjected to shear, rather than tensile loading, where strength of full nut is not required. Can also be used in pairs, or with plain nuts to provide locking action.

Materials: Steel, brass and other materials.

Sizes: ¼ to 4 in.; Coarse, Fine or 8-thread series; Class 2B. Body styles include regular, regular semi-finished, heavy semifinished and finished.

Source: American Standard *Square and Hexagon Bolts and Nuts* —ASA B18.2 1955.

Johnson Weldnut

Form: Square nut with four upset weld projections on lower surface. Nut is projection welded in place.

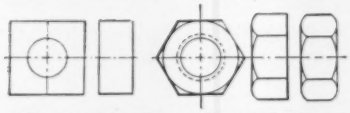
Design Features: Provides permanent nut attachment for parts where tapped hole is impractical.

Material: Low-carbon steel.

Sizes: ¼ to ⅝-in.; all standard threads. Body styles are regular and heavy square.

Source: Produced under license by several manufacturers. Information and photo, courtesy The National Screw and Mfg. Co., Cleveland.

Machine Screw & Stove Bolt Nuts



Form: One-piece, threaded square and hexagon nuts for use with machine screws and stove bolts.

Design Features: General-purpose nuts for moderately loaded assemblies. Hexagon machine screw nut has flat and chamfered top and flat bottom. Square machine screw and stove bolt nut has flat top and bottom.

Materials: Steel, brass, aluminum and other materials.

Sizes: No. 0 to ⅜-in.; Coarse and Fine threads; Class 2B.

Source: American Standard *Square and Hexagon Bolts and Nuts* —ASA B18.2-1955.

Midland Weldnut

Form: Square nut with pilot shoulder and four projections on bottom face; corners are chamfered. Pilot shoulder is inserted into prepared hole in part and nut is welded into place.

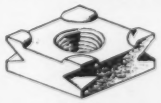
Design Features: Provides a low-cost, rapidly assembled nut or tapped hole. Frequently used on steel stampings where joining would be difficult or costly by other methods. Can be readily adapted to high-speed feeding devices and machine assembly methods. Pilot design facilitates positioning of nut in assembly. Where necessary, pilot may be welded directly to part.

Materials: Steel.

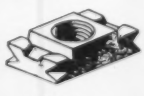
Sizes: No. 6 to ⅝-in.; Coarse and Fine threads. Class 2B. Body styles include regular and thin as well as others.

Source: The Midland Steel Products Co., Detroit.

Mount Clemens Weld Nuts



Solid



Pilot

Form: All-metal modified square nut with weld projections on corners of bottom face. Nut is projection or spot welded in position.

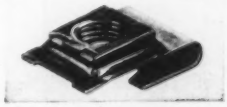
Design Features: Provides a low-cost prepositioned nut.

Materials: Steel.

Sizes: No. 8 to ⅜-in.; Coarse and Fine threads. Body styles include solid, pilot, caged, floating and double-caged.

Source: Mount Clemens Metal Products Co., Detroit.

Nut Clip



Form: Single-unit clip-on nut assembly consisting of square nut fixed to sheet-metal clip that slips on over edge of panel or thin section.

Design Features: Provides heavy duty, nut member that does not have to be held in place when the bolt is assembled. Tongue of clip acts as lockwasher when assembly is tightened. Used on panels or thin sections where edge fastening is required.

Materials: Steel.

Sizes: No. 10 to ⅜-in.; Coarse and Fine threads.

Source: Prestole Corp., Toledo.

Ohio Weld Nuts

Form: Rectangular plate nut with weld projections and pilot collar on bottom face. Pilot collar is mounted in prepared hole and nut projection welded in place.

Design Features: Provides a low-cost, rapidly assembled permanent nut or tapped hole. Pilot collar facilitates assembly and adds extra depth of thread engagement. Can be used on tubular sections, narrow flanges, confined corners, close spacing and narrow channels in blind or open locations.

Materials: Low-carbon steel.

Sizes: No. 6 to ⅜-in.; Coarse and Fine threads. Body styles include several different types for projection and spot welding.

Source: Ohio Nut & Bolt Co., Berea, O.

Pem Self-Clinching Nut

Form: One-piece, all-metal self-clinching nut. Bottom external surface of round nut body is reduced in diameter and has reverse taper. Nut is pressed into prepared hole and metal extruded against tapered shank locks nut in place.

Design Features: Provides rapidly assembled nut anchor for blind or open locations in thin metal members. Tapered shank of nut acts as pilot. Round shape facilitates assembly. Clinching ring in base of nut squeezes sheet material around shank to produce positive lock. Suitable for use with material thicknesses down to 0.040-in.

Materials: Steel, stainless steel, Monel or aluminum.

Sizes: No. 2 to ¾-in.; Coarse and Fine threads. Optional grip lengths.

Source: Penn Engineering & Mfg. Corp., Doylestown, Pa.

Pem Weld Nut

Form: All-metal, round body weld nut with three weld projections and extended round shank on bottom surface. Nut is projection welded to part with extended shank serving as pilot in assembly.

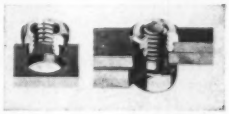
Design Features: Provides load bearing thread anchor for sheet-metal or other parts where tapping is impractical. Round body and extended shank pilot facilitate assembly. Fits into narrow flanges. Extended shank protects threads from weld spatter.

Materials: Mild steel or stainless steel.

Sizes: No. 2 to ¼-in.; Coarse and Fine threads.

Source: Penn Engineering & Mfg. Corp., Doylestown, Pa.

Plug Nut



Form: One-piece, all-metal self-clinching nut. Body is in form of hardened round nut in which bottom end is reduced in diameter and tapered. Nut is pressed or driven into prepared hole, seating head. Tapered section locks in hole to hold nut in place.

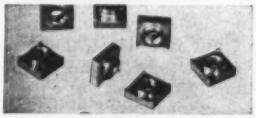
Design Features: Reusable. Self centering. Provides standard length of thread engagement in thick or thin parts. Provides flat surface on blind side for assembly of mating parts. Can be assembled from one side. Suitable for use with almost any metal. Provides a strong thread anchor in blind or open locations where an ordinary nut cannot be used, where full strength is necessary or where limited protrusion is required.

Materials: Steel, aluminum, brass or stainless steel.

Sizes: No. 4 to ½-in.; all standard tapped threads.

Source: The Lamson & Sessions Co., Cleveland.

Quintlock Nut



Form: One-piece, all-metal self-clinching nut. Nut has square head and round shank of reduced diameter with reverse surface taper. When nut is pressed into prepared hole and head seated against part surface, prongs on corners of head imbed in surface to prevent turning, and tapered shank locks against hole wall to resist pull out.

Design Features: Provides flush-mounted tapped hole in soft sheet metal parts. Can be assembled with hammer, using special backing tool. Suitable for material thicknesses of 0.038-in. and over. Used to join sheet-metal sections to each other or to other parts.

Materials: Steel.

Sizes: No. 4-40 to ¼-20; machine screw threads.

Source: Fox Products Co., Philadelphia.

Slotted Nuts

Form: Regular hexagon nut with slots milled across the flats on one face. Cotter pin or safety wire inserted in drilled hole in bolt can be used to lock nut in place.

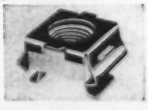
Design Features: General-purpose nut that can be readily adapted to provide locking features. Finished series is designed for average use. Heavy series is thicker and wider and is suitable for use with heavy loads and large bolt clearances.

Materials: Steel, brass, aluminum and other standard materials.

Sizes: ¼ to 4-in.; Coarse, Fine and 8-thread series; Class 2B. Body styles include regular semifinished, heavy semifinished, finished and finished thick.

Source: American Standard *Square and Hexagon Bolts and Nuts* —ASA B18.2-1955.

Speed Grip



Form: Two-piece, snap-in nut assembly consisting of standard square nut mounted loosely in stamped, sheet-metal cage with projecting prongs. Prongs snap into prepared hole to hold nut in place.

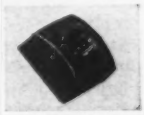
Design Features: Provides securely attached nut that does not have to be held when bolt is tightened. Can be assembled by hand. Provides secure retainer for square nuts in blind locations on sheet metal panels or thin sections.

Materials: Cage is heat-treated spring steel; nut is steel.

Sizes: No. 6 to ½-in.; Coarse and Fine threads.

Source: Tinnerman Products Inc., Cleveland.

Square Nuts



Form: One-piece, all-metal, standard threaded square-body nut.

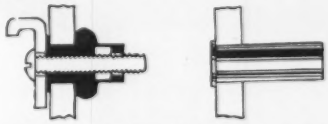
Design Features: General-purpose nut. Not finished on any surface. Top of nut is flat and chamfered or washer crowned.

Materials: Steel, brass, aluminum and other standard materials.

Sizes: ¼ to 1½ in.; Coarse threads; Class 2B. Body styles include regular and heavy.

Source: American Standard *Square and Hexagon Bolts and Nuts* —ASA B18.2-1955.

Well-Nut



Form: Single-unit, blind anchor nut consisting of rubber sleeve with flange at one end and brass nut bonded in other end. Sleeve is pressed into drilled hole with flange against part surface and screw is inserted to engage nut. Tightening of screw causes rubber sleeve to draw in tightly against back of part and form blind head.

Design Features: Provides a resilient thread anchor for blind or open locations in thin plastics, porcelain, glass and other materials difficult to fasten. As sleeve is drawn tight, rubber is forced into threads of the screw, preventing air or water leakage and loosening by vibration. Lightweight. Reduces sound transmission and prevents squeaks. Can be expanded against side of cavity.

Materials: Sleeve is natural or

neoprene rubber composition; nut is brass.

Sizes: No. 6-32, No. 10-32 and ¼-20. Body diameters from ⅛ to ½-in. Lengths from ⅛ to 3¼-in.

Source: Rockwell Products Corp., Newark, N. J.

Wing and Thumb Nuts

Form: One-piece, all-metal, round threaded nuts with wing lugs or with wide head that is knurled or scalloped on the edge for ease of manual assembly.

Design Features: Provide a large finger gripping surface for manual assembly. Particularly suited to applications where frequent removal and replacement or adjustment of nuts are required. Provide a neat appearance.

Materials: Steel, brass, aluminum, zinc and other materials.

Sizes: No. 4 to ¾-in.; Coarse and Fine threads.

Source: Produced by several manufacturers. Photos, courtesy Gries Reproducer Corp., New Rochelle, N. Y.

LOCKNUTS

Anco-Nut

Form: Single-unit, all-metal prevailing-torque locknut. End of locking pin mounted to nut travels between threads of bolt to provide ratchet-like locking action.

Design Features: Reusable. Provides continuous positive locking action when locking pin is engaged. Assembled and removed with wrench. Cost is comparable to conventional nut and lock washer. Provides secure seated locknut or stop nut where effect of vibration is a problem.

Materials: Nut is open-hearth carbon steel with rust resistant locking pin.

Sizes: ¼ to 3 in.; Coarse and Fine threads; Class 2B. Body styles include heavy, regular and finished hex.

Source: Automatic Nut Co. Inc., Lebanon, Pa.

An-Cor-Lox Locknut

Form: Single-unit, all-metal, free-spinning locknut. Metal insert in base of nut is crushed when seated to develop wedge-locking action.

Design Features: Reusable. Wedge-locking action resists severe vibration and stress conditions, relatively high temperatures and repeated immersion and drying. Can be assembled with standard wrenches. Bolt does not have to protrude through nut for full locking efficiency. Crushed insert compensates for misalignment of bolt or nut, and forms liquid and gas-tight seal.

Materials: Nut body is carbon steel; insert is bronze.

Sizes: ¼ to 1½ in.; NC, NF, UNC and UNF threads; Class 2 and 3. Body styles include hex and others.

Source: An-Cor-Lox Div., Schnitzer Alloy Products Co., Elizabeth, N. J.

Boots Axial Locking Nuts

Wing-Style Rol-Top Bellows

Form: One-piece, all-metal, prevailing - torque locknut. Upper threaded section of nut, which is separated from lower main body by bellows-type construction, is slightly offset downward to produce out-of-phase thread relation. As bolt enters, height of nut expands to permit passage. Spring action of upper nut section develops positive axial locking force.

Design Features: Reusable. Provides continuous locking grip when upper nut section is engaged. Maintains secure lock under severe operating conditions. Maximum application temperature varies from 250 to 800 F, depending on material.

Materials: Dural-aluminum, Duronze, corrosion-resistant steel, aluminum or mild steel.

Sizes: No. 6 to 9/16-in. NC and NF threads, Class 2B and 3B. Body styles include hex, anchor and channel base.

Source: Boots Aircraft Nut Corp., Norwalk, Conn.

Boots Radial Locking Nuts

Plate-Lok Jet-Lok Hex-Lok

Form: One-piece, all-metal, prevailing-torque locknut. Upper section of nut has flared petals, curving in and down. Spring tension of petals develops powerful radial locking grip on bolt threads.

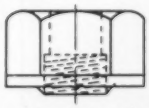
Design Features: Reusable. Provides continuous locking grip when petal section is engaged. Locking action resists severe vibration conditions.

Materials: Steel and corrosion-resistant steel.

Sizes: No. 10 to ⅜-in.; NF-3B threads. Body styles include full and thin hex, anchor, and channel base.

Source: Boots Aircraft Nut Corp., Norwalk, Conn.

Brilok Stop Nut



Form: One-piece all-nylon prevailing-torque locknut. Bore of nut is only partially tapped. As screw enters unthreaded portion of bore, thread-forming action of screw thread develops a strong friction lock.

Design Features: Reusable. Provides a durable, lightweight nut that resists vibration and is noncorrosive and electrically nonconductive. Resilient nylon construction permits nut to be reused even after stripping; threads reform when nut is removed and replaced. Can be assembled with standard tools.

Materials: Zytel 101.

Sizes: No. 4 to ¼-in.; Coarse and Fine threads. Body style is hex with washer face.

Source: American Screw Co., Willimantic, Conn.

Columbia Locknut

Form: Two-piece, all-metal, free-spinning locknut consisting of upper split-nut element with tapered neck that fits into mating tapered seat in lower main nut section. When upper element is tightened into tapered seat, it is radially compressed to develop locking grip on bolt threads.

Design Features: Reusable. Provides positive locking grip that resists severe vibration. Both members are free spinning until locked. Can be assembled as seated locknut with one wrench or as stop nut with two.

Materials: Steel.

Sizes: ¼ to 2 in.; Coarse and Fine threads. Body style is hex.

Source: Columbia Nut & Bolt Co. Inc., Bridgeport, Conn.

Delron No. 5 Locknut

Form: Single-unit, all-metal, free-spinning locknut assembly consisting of split, hexagonal threaded core mounted in shell welded to base plate. When base plate is seated, further tightening develops locking action.

Design Features: Reusable. Free spinning until seated. Develops prevailing-torque action when locked. After backing off nut, locking action can be released manually to permit free-spinning removal. Resists extreme vibration. Provides self-locking nut with integral washer.

Materials: Corrosion - resistant steel.

Sizes: ¼ to 7/16-in.; UNF threads. Body style is hex.

Source: The Delron Co. Inc., South Gate, Calif.

Dura-Loc 1600 Locknut

Form: Single-unit, all - metal, free-spinning locknut consisting of split, tapered, threaded core keyed into metal shell with mating tapered bore. When shell is seated, further rotation of nut forces core downward to produce collet-type locking action.

Design Features: Reusable. Maximum application temperature is 1600 F. Locking action is equally effective on high or low tolerance bolt threads. Provides vibration-resistant seated locknut under high temperature conditions.

Materials: Stabilized corrosion-resistant steels.

Sizes: No. 6 to 7/16-in.; UNC and UNF threads. Body style is hex.

Source: The Delron Co. Inc., South Gate, Calif.

Esna All-Metal Locknut

Form: One-piece, all-metal, prevailing - torque locknut. Upper threaded conical crown is slotted to form six radial beams which are deflected inward. Beam sections grip screw thread firmly to provide tight friction lock.

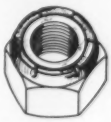
Design Features: Reusable. Designed for use at temperatures from 250 to 1200 F. Provides constant locking action at any position on bolt when beam sections are fully engaged. Relief provided by slots assures that locking grip is evenly applied, without destructive galling of bolt threads or plating.

Materials: Steel, copper-base alloy and stainless steel.

Sizes: No. 4 to ¾-in.; NF and NC threads, Class 3. Body styles include hex, double hex, anchor, weld and rivet types, and others.

Source: Elastic Stop Nut Corp. of America, Union, N. J.

Esna Insert Type Locknut



Form: Single-unit, prevailing-torque locknut consisting of metal nut body with elastic fiber or plastic compression collar built into top of nut. Elastic collar distorts when threaded on screw to provide friction locking action.

Design Features: Reusable interchangeably within tolerance limits of Class 3 screws; elastic collar compensates tolerance variations. Provides constant uniform locking grip at any position on bolt when collar is in full engagement. Maintains secure lock under severe operating conditions. Collar serves as liquid seal, preventing thread corrosion and assuring easy removal of nut. Maximum application temperature is 250 F.

Materials: Nut body is steel, aluminum, brass and corrosion resistant steel; collar is red fiber or red nylon.

Sizes: No. 0-80 to 2-4½; NC, NF and 8 thread series. Body styles include hex, clinch, anchor, spline, barrel, weld and many others.

Source: Elastic Stop Nut Corp. of America, Union, N. J.

Everlock Locknut

Form: One-piece, all-metal, free-spinning locknut made from a stamping. Nut has concave base which flattens when tightened against seat, forcing six threaded tines inward against the bolt threads to develop tight locking grip.

Design Features: Reusable. Spins down freely and rapidly until seated. Weight is 1/3 that of comparable standard hex nut. Maximum application temperature is 550 F. Provides low-cost, rapidly assembled locknut.

Materials: Heat-treated high-carbon steel.

Sizes: No. 8 and 10, and ¼-in.; NC and NF threads. Body style is hex.

Source: Thompson-Bremer & Co., Subsidiary of American Machine & Foundry Co., Chicago.

Expansion Nut

Form: One-piece, all-metal, prevailing-torque locknut made as stamping. Nut is snapped into square hole in panel or thin section by hand. Spring arms are spread apart by screw thread, wedging nut in position and providing a secure locking action.

Design Features: Reusable. Resists loosening of vibration. Can be assembled in blind locations. Locking action compensates for thread tolerance variations. Provides low-cost locking fastener in light assemblies.

Materials: Heat-treated spring steel.

Sizes: No. 6 to No. 10; sheet-metal screw threads.

Source: Tinnerman Products Inc., Cleveland.

Fishtail Fasteners

Form: One - piece, all - metal, spring-action locknut for unthreaded studs. Nut is pressed onto unthreaded stud and teeth around circular opening bite into surface to produce firm locking grip.

Design Features: Reusable. Adaptable to high-speed assembly. Resists vibration. Locking grip is independent of the pressure of spring take-up legs. Can be used on flat or contour surfaces.

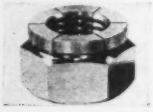
Materials: Steel.

Sizes: 1/16 to ½-in. stud diam-

eters.

Source: United-Carr Fastener Corp., Cambridge, Mass.

Flexloc Locknut



Form: One-piece, all-metal, prevailing-torque locknut. Top of nut is shaped like collar and slotted to form six threaded segments which are deflected inward. Slotted sections "pressure grip" screw thread to provide locking action.

Design Features: Reusable. Spins on freely on screw thread until locking collar is engaged, then wrench is used. Provides constant locking torque at any position on screw when collar is fully engaged. Will resist loosening effects of severe vibration.

Materials: Steel, corrosion-resistant steel, brass and aluminum.

Sizes: No. 2 to 2 in.; NC, NF and 8-thread series; Class 2B and 3B. Body styles include regular and thin hex, aircraft hex and 12 point, clinch, and others.

Source: Standard Pressed Steel Co., Jenkintown, Pa.

GRC Locking Wing Nut

Form: One-piece, all-metal free-spinning wing locknut. Serrations in bottom surface of nut grip part surface when nut is seated to provide locking action.

Design Features: Reusable. Can be rapidly assembled by hand. Eliminates separate handling of nut and lockwasher.

Materials: Zinc.

Sizes: No. 10 to ½-in.; Coarse and Fine threads.

Source: Gries Reproducer Corp., New Rochelle, N. Y.

Greer Stop Nut

Form: Single unit, prevailing-torque locknut consisting of metal nut body with elastic fiber or plastic insert built into top of nut. Resilient insert is compressed by bolt threads and produces constant friction grip.

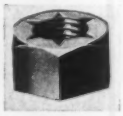
Design Features: Reusable. Provides continuous locking action when collar is fully engaged. Collar seals against fluid leakage. Maintains secure lock under severe operating conditions.

Materials: Nut body is steel, stainless steel, brass, or aluminum; insert is green fiber or nylon.

Sizes: No. 0 to 1¼ in.; NC and NF threads, Class 2B and 3B. Body styles include full and thin hex, high tensile hex, miniature, clinch, spline, instrument and cap.

Source: Greer Stop Nut Co., Chicago.

Gripco Locknut



Form: One-piece, all-metal, prevailing-torque locknut. Triangular depressions in upper surface of nut deflect top thread to provide controlled friction locking action.

Design Features: Reusable. Provides positive continuous vibration-resistant holding action in any position on bolt when deflected thread is engaged. Nut dimensions identical to standard semifinished nut. Nuts are single chamfer, washer faced.

Materials: Steel.

Sizes: No. 6 to 1½ in.; UNC and UNF threads: Class 2B. Body styles include regular, jam, and high hex, weld, clinch and flange.

Source: Grip Nut Co., Chicago.

Hi-Stress

Form: One-piece, all-metal, prevailing-torque locknut. Body of nut is in form of threaded split sleeve with flange base. Split sleeve is tapped slightly smaller than bolt thread to produce locking fit.

Design Features: Reusable. Provides constant locking torque at any position on bolt. Provides low cost seated locknut or stop nut.

Materials: Heat-treated spring steel.

Sizes: No. 4 to 5/16-in.; Coarse and Fine threads.

Source: Tinnerman Products Inc., Cleveland.

Huglock

Form: One-piece, all-metal, prevailing - torque locknut. Upper threaded portion of nut is tapered and slotted to form six segments which are curved inward. Segments press in and down on screw threads to produce secure friction locking action.

Design Features: Reusable. Nut starts freely on screw thread and is easily assembled with standard hand or speed wrenches. Provides constant locking action at any position on bolt when slotted section is engaged. All metal design provides maximum shear strength. Resists severe shock and vibration conditions.

Materials: Carbon steel, corrosion-resistant steel, brass, and aluminum.

Sizes: No. 10 to 1½ in.; UNC and UNF threads, Class 2B. Body styles include thin, regular and thick hex as well as others.

Source: National Machine Products Co., Utica, Mich.

Jacobson Locknut

Form: One-piece, all-metal free-spinning locknut. Upper portion of nut is slotted and bottom face is undercut. When nut is tightened against seat, upper slotted segments are forced inward to develop locking grip on bolt threads.

Design Features: Reusable. Resists vibration. Provides a low-cost, seated locknut.

Materials: Steel, brass, aluminum or stainless steel.

Sizes: All machine screw threads.

Source: Jacobson Nut Mfg. Corp., Kenilworth, N. J.

Jacobson Stop Nut

Form: One-piece, all-metal prevailing-torque locknut.

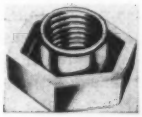
Design Features: Reusable. Provides a low-cost seated locknut or stop nut. Resists vibration.

Materials: Steel, brass, aluminum or stainless steel.

Sizes: All machine screw threads.

Source: Jacobson Nut Mfg. Corp., Kenilworth, N. J.

Kaylock Locknut



Form: One-piece, all-metal, prevailing - torque locknut. Upper threads are deformed into elliptical shape to develop locking action.

Design Features: Reusable. Provides lightweight locknut with high strength-weight ratio. Locking action is continuous when elliptical threads are engaged. Maximum application temperature is 550 F.

Materials: Heat-treated carbon steel.

Sizes: No. 4 to ½-in.; NC, NF, and UNF threads, Class 3. Body styles include hex, fixed and floating anchor, gang channel and others.

Source: Kaylock Div., The Kaynar Co., Los Angeles.

Keps

Form: Single-unit, all-metal, free-spinning locknut consisting of preassembled standard nut and toothed lockwasher.

Design Features: Reusable. Eliminates need for separate assembly of washer and nut. Lockwasher is free to turn. Provides low-cost, rapidly assembled locknut. Can be readily adapted to self-sealing lockwasher designs.

Materials: Mild steel.

Sizes: No. 5 to ⅜-in.; Coarse and Fine threads. Body styles are finished hex and machine screw types.

Source: Shakeproof Div. of Illinois Tool Works, Elgin, Ill.

Klincher Locknut

Form: Single unit, all-metal, free-spinning locknut. Grooved washer at bottom of nut is pressed over threaded section suspended from main nut body. When seated under proper torque, washer compresses causing inner threaded section to move in and lock radially and axially on bolt.

Design Features: Reusable. Spins down freely until washer is seated. Bulk of load moves up into main body of nut when locking threads elongate under their load. Reduces high stress concentration and torsional load normally found in first three threads in nut and bolt, permitting added wrench torque to be applied before elastic limit of nut is exceeded. Maximum application temperature is 1600 F. Provides vibration-resistant bolted connection that holds solid and resists thread wear.

Materials: Stainless steel.

Sizes: No. 2 to 1 in.; Coarse and Fine threads. Body styles include standard and thin hex.

Source: Klincher Locknut Corp., Indianapolis.

Lamson Locknut

Form: One-piece, all-metal, prevailing-torque locknut. Heat-treated, threaded crown collar at top of standard nut body is slightly distorted from round and produces vise-like locking grip on bolt threads.

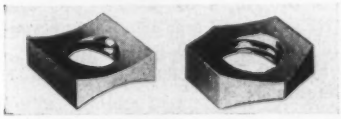
Design Features: Reusable. Spins freely on bolt until threads of locking collar are engaged, then wrench is used. Locks in any position on bolt when collar is engaged. When working threads in main body of nut assume load, grip threads in collar are free to exert full locking pressure. Eliminates pitch interference since thread has same lead throughout. Withstands temperatures to 800 F and severe vibration.

Materials: High - carbon heat-treated steel.

Sizes: No. 10 to 2 in.; all standard threads; Class 3.

Source: The Lamson & Sessions Co., Cleveland.

M-F Locknut No. 1



Form: One-piece, all-metal, free-spinning locknut. Arched surface of nut flattens when tightened against top of conventional nut, causing threads to deflect from true helix and to bind on bolt threads.

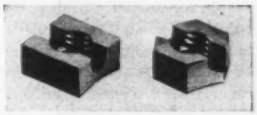
Design Features: Spins freely until seated. Nut takes permanent set when seated and must be wrenched for further movement. Used primarily to hold conventional nonlocking nuts in place on heavy machinery.

Materials: Steel.

Sizes: ¼ to 2 in.; Coarse and Fine threads, Class 2B. Body styles include regular and heavy hex or square.

Source: MacLean-Fogg Lock Nut Co., Chicago.

M-F Speed Holding Nut



Form: One-piece, all-metal, free-spinning locknut. Lower arched surface of nut flattens when seated, causing top to pinch in and to bind on bolt threads.

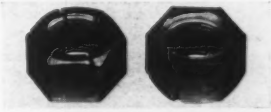
Design Features: Lightweight. Spins freely until seated. Provides low-cost, reliable, seated locknut.

Materials: Steel.

Sizes: ¼ to ⅝-in.; Coarse and Fine threads; Class 2B. Body styles include regular square and hex.

Source: MacLean-Fogg Lock Nut Co., Chicago.

Marsden Locknut



Form: One-piece, all-metal, free-spinning locknut. Upper part of nut is slotted to form several threaded segments. Bottom face is recessed so that seating surface is outside of thread pitch line. When nut is tightened against unyielding base, pressure on seating surface forces threaded upper segments to move radially inward to produce friction locking action.

Design Features: Reusable. Spins down easily until seated. Friction-locking action resists vibration. Area of thread contact, when locked, is greater than conventional nut. Can be readily adapted to high-speed assembly methods. Well established as rugged, dependable locknut.

Materials: Carbon steel, stainless steel, brass, bronze, and aluminum.

Sizes: ¼ to 1½ in.; UNC and UNF threads, Class 2B. Body styles include full and thin hex as well as many others.

Source: Produced under license by several manufacturers in U.S.A., Canada and other countries. Information, courtesy Industrial Fasteners Institute, Cleveland. Photo, courtesy National Screw and Mfg. Co., Cleveland.

Morse Hi-Load Spring Locknut

Form: Single-unit, all-metal, free-spinning locknut consisting of nut with conical-shaped lower section that mates with hardened steel washer. When nut is "bottomed," washer acts as spring to compress and lock nut threads against bolt under predetermined radial pressure.

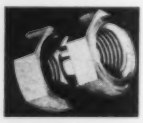
Design Features: Reusable. Provides accurate control of bolt preload and can be assembled with conventional wrench. Resists severe vibration. Especially suited for difficult locations. Free spinning until seated.

Materials: Nut is low carbon steel; washer is hardened alloy steel.

Sizes: ¼ to ½-in.; Coarse and Fine threads.

Source: Morse Products Development Co., Los Angeles.

National Drake Locknut



Form: Two-piece, all-metal, free-spinning locknut consisting of lower working nut element with flexible, slotted crown and upper locking member. When upper member is tightened over flexible crown section, slotted sections are radially compressed to develop tight locking grip.

Design Features: Reusable. Provides high-force positive locking action. Load from working nut is not transferred to locking member as with conventional jam nut. Both members are free spinning until locked. Nut can be locked at any position on bolt by using two wrenches. Used primarily on rugged, heavy equipment where stress, shock or vibration conditions are unusually severe.

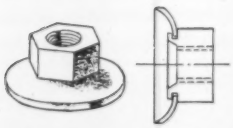
Materials: Steel.

Sizes: ¼ to 1 in.; Coarse and Fine threads; Class 2B. Body style is hex.

Source: The National Screw & Mfg. Co., Cleveland.

Nut Washers

Form: Single-unit, free-spinning locknut consisting of preassembled nut and lockwasher. Dished washer provides spring locking action when nut is seated.



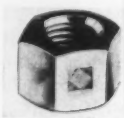
Design Features: Reusable. Provides low-cost, rapidly assembled locknut. Washer turns freely on nut but can't drop off. Eliminates need for separate handling of washer and nut. Can be readily adapted to self-sealing washer designs.

Materials: Steel.

Sizes: No. 10 to 5/16-in.; Coarse and Fine threads.

Source: Mount Clemens Metal Products Co., Detroit.

Nylok Locknut



Form: Single-unit, prevailing-torque locknut consisting of a standard hex metal nut body with radial nylon plug mounted in one side. Plug wedges mating threads in nut and screw together to provide locking action.

Design Features: Reusable. Provides secure vibration-resistant locking action. Will lock at any position on screw thread where plug is engaged. Nut can be threaded from either end, facilitating mechanical assembly and feeding methods. Works effectively on threads of varying pitch diameter. Nylon plug acts as dam to block flow of fluids or gases along threads. Useful temperature range is −70 to 250 F. Used to provide secure seated locking fastener or stop nut for screw adjustments.

Materials: Low-carbon steel, corrosion-resistant steel, brass and aluminum.

Sizes: No. 4 to ¾-in.; UNC and UNF, Class 2B and 3B. Body styles include clinch and cap.

Source: The Nylok Corp., Elmira Heights, N. Y.

Palnut Adjusting Nut

Form: One-piece, all-metal, prevailing-torque locknut. Top portion of nut exerts constant radial spring clamping force on screw thread. Base has arched, slotted, thread-engaging section that is free-running until seated but produces spring-locking action when tightened against surface.

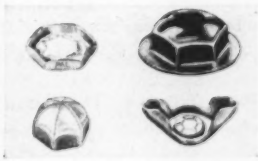
Design Features: Reusable. Lightweight. Maximum application temperature is 400 F. Resists vibration. Can be used with conventional driving methods for rapid assembly. Spins on freely until top portion is engaged, then is wrench tightened. Used as seated load-carrying locknut or as adjusting nut on light assemblies.

Materials: High-carbon spring steel.

Sizes: No. 6 to 5/16-in.; Coarse and Fine threads; Class 2B. Body style is acorn.

Source: The Palnut Co., Mountainside, N. J.

Palnut Locknut



Form: One-piece, all-metal free-spinning locknut. Compression of arched base coupled with inward gripping motion of arched, slotted thread-engaging section produces secure locking action as nut is tightened against seat.

Design Features: Reusable. Locking action remains effective as long as center section is not unduly flattened by excessive torque. Can be used with all standard nut driving methods for rapid assembly. Light in weight. Maximum application temperature is 400 F. Resists vibration. Provides low-cost seated locknut for light assemblies or to lock standard nuts on heavy assemblies.

Materials: High-carbon spring steel.

Sizes: No. 3 to 2½-in.; Coarse, Fine, Pipe and other threads; Class 2B. Body styles include square, hex, inverted, washer, tension, acorn, wing and other types.

Source: The Palnut Co., Mountainside, N. J.

Plastic Nut

Form: One-piece, all-plastic snap-in locknut. It is snapped into prepared hole and locked in place by tapping screw.

Design Features: Provides low-cost, locking screw receptacle for blind or open locations that is vibration resistant. Develops high holding strength and load capacity.

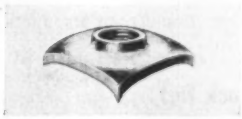
Will not mar surface finishes. Is noncorrosive and electrically nonconductive.

Materials: Nylon.

Sizes: No. 6-32 to 5/16-18, thread-cutting tapping screws. Grip length is ⅛-in.

Source: (Plasti-Grommet) Fastex Div. of Illinois Tool Works, Des Plaines, Ill.; (Snap-in Nut) United Carr Fastener Corp., Cambridge, Mass. Photo, courtesy Fastex Div.

P-M Nut



Form: One-piece, all-metal, free-spinning locknut. Compression of arched base of nut when screw is tightened applies tension to mating threads to develop locking action.

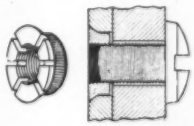
Design Features: Reusable. Turned down corners of nut grip seating surface while screw is being tightened, eliminating need for wrench holding. Concave shape of base facilitates assembly of screw. Provides low-cost, rapidly assembled, vibration-resistant locknut.

Materials: Hardened and spring-tempered high-carbon steel.

Sizes: No. 6-32 to 10-32. Body style is square.

Source: P-M Nut Div., The Waterbury Pressed Metal Co., Waterbury, Conn.

Pow'Rgrip Locknut



Form: One-piece, all-metal, self-clinching, self-locking nut. One end is cone shaped and slotted; other end has knurled surface. Nut is partially pressed or driven into drilled and countersunk hole and held in position by gripping action of knurls. When fastener is inserted in knurled end and tightened, insert is further drawn into hole, forcing slotted cone segments inward to develop locking action.

Design Features: Retains locking action when screw is removed and reassembled. Locking forces are developed by interference of slotted section, which has cone angle of 63 degrees, with 60 degree countersunk seat. Used to provide quickly assembled tapped hole in plate or "soft" metal members of at least 3/16-in. thickness.

Materials: Steel.

Sizes: No. 6 to 5/16-in., Coarse and Fine threads.

Source: Allmetal Screw Products Co. Inc., Garden City, N. Y.

Prestole Push-On Fastener

Form: One-piece, all-metal spring-action locknut for unthreaded stud members. Nut is pushed on over stud surface. Compression of arched base coupled with inward "biting action" of two gripping elements produces firm spring tension lock when nut is seated.

Design Features: Reusable. Adaptable to high speed assembly methods. Locking action is not affected by variations up to $\frac{1}{64}$-in. in stud diameter. Can be used on any material. Provides low-cost high-production locking fastener for light assemblies with stud elements.

Materials: Cold-rolled steel or spring steel.

Sizes: $\frac{3}{32}$ to $\frac{7}{16}$-in. stud diameters.

Source: Prestole Corp., Toledo, O.

Prestole Spring-Action Fasteners

Form: One-piece, all-metal, free-spinning locknut made as stamping. Spring-action of thread engaging element, which develops 360-degree clamp on root of screw thread, produces firm locking grip.

Design Features: Reusable. Resists loosening effect of vibration. Thread engaging element provides natural screw lead. Adaptable to high-speed assembly methods. Provides low-cost high-production locking fastener.

Materials: Spring steel and cold-rolled steel.

Sizes: No. 6 to No. 14; sheet-metal screw threads. Body styles include weld, bridge spacer, C-clip, J-clip, tandem and others.

Source: Prestole Corp., Toledo, O.

Pushnut

Form: One-piece, all-metal, spring-action locknut for unthreaded members. Nut is pressed or tapped onto unthreaded surface. Spring-clamping action of fingers around circular nut opening provides firm locking grip when nut is seated.

Design Features: Reusable. Adaptable to high-speed assembly methods. Resists vibration. Lends itself to knock-down assembly. Provides low-cost, rapidly assembled locking fastener for lightly loaded unthreaded rod, axles or rivets.

Materials: Heat-treated spring steel.

Sizes: 0.120 to $\frac{5}{16}$-in. rod diameter. Body styles include closed and open end acorn and flat.

Source: The Palnut Company, Mountainside, N. J.

Push-On Speed Nut

Form: One-piece, all-metal, spring-action locknut for unthreaded parts. Nut is pushed on over unthreaded surface. Compression of arched base coupled with inward "biting" action of two prongs produces firm spring tension lock when nut is seated.

Design Features: Reusable. Adaptable to high speed assembly methods. Resists vibration. Provides low-cost high-production locking fastener for lightly loaded unthreaded studs, rivets or other similar parts.

Materials: Heat-treated spring steel.

Sizes: $\frac{3}{64}$ to $\frac{3}{4}$-in. stud diameters.

Source: Tinnerman Products Inc., Cleveland.

Security Locknut

Form: Single-unit, all-metal, prevailing-torque locknut consisting of standard nut body with locked-in, threaded, elliptical spring-steel insert. Elastic spring action of insert develops high radial locking pressure on threads of bolt.

Design Features: Reusable. Locks in any position on bolt when insert threads are engaged. Loads are carried by nut body only, insert acts solely as lock. Rotation of insert is prevented by projecting ear. Resists vibration and shock.

Materials: Nut body is steel.

Sizes: $\frac{1}{8}$ to 3 in. Body styles in-

clude regular and jam hex in finished and heavy types, cap and square.

Source: Security Locknut Corp., Melrose Park, Ill.

Self-Retaining Locknut

Form: One-piece, all-metal, prevailing-torque locknut. Upper portion of nut has horizontal slit and develops spring tension when turned onto bolt to provide firm friction lock.

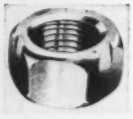
Design Features: Reusable. Starts freely by hand and then is wrench tightened when upper part engages bolt. Provides a low-cost secure seated locknut or stop nut.

Materials: Steel.

Sizes: ¼ to 2 in.; Coarse and Fine threads.

Source: Columbia Nut & Bolt Co. Inc., Bridgeport, Conn.

Shakeproof Lokut



Form: One-piece, all-metal, prevailing-torque locknut. Upper part of nut wall has shear depressions at three points causing top threads to project inward. Radial compression forces developed by deflected threads produce powerful friction locking action on bolt.

Design Features: Reusable. Nut starts freely, then wrench is used. Provides continuous clamping force on bolt when deflected threads are engaged. Locking action is unaffected by temperature changes, bolt stretch or variation of work pressure. Ideally suited for applications involving spring compression or where fragile work surface makes it impossible to draw nuts down for surface locking action.

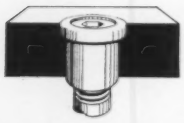
Materials: Steel.

Sizes: No. 8 to ½-in.; Coarse and Fine threads, Class 2B. Body style is hex.

Source: Shakeproof Div. of Illinois Tool Works, Elgin, Ill.

Shur-Lok Flange Locknut

Form: Two-piece, prevailing-torque locknut consisting of threaded insert and ceramic-coated metal shell. Insert threads are partly compressed to develop locking grip on screw thread.



Design Features: Reusable. Ceramic coating provides dielectric and anticorrosion qualities. Design of nut, which fits into counterbored hole, provides flush, electrically insulated surface at top of part to be attached. Maximum application temperature is 1200 F. Provides continuous locking action on screw thread. Especially suited for attaching insulating components used in high-temperature electrical equipment.

Materials: Nut body and shell are stainless steel.

Sizes: No. 10-32 UNF-3B. Body style is flanged, internal wrenching.

Source: Shur-Lok Corp., Fullerton, Calif.

Snap Nut

Form: One-piece, all-metal, prevailing-torque locknut made as stamping. Nut is snapped into square hole in panel or thin section. Spring arms, which expand when screw thread enters, bind against root of thread to provide locking action.

Design Features: Reusable. Resists vibration. Spring tension of nut prevents "dead tight" fastening, thus avoiding marring of finished surfaces. Can be used with either screws or studs. Provides low-cost locking fastener for blind locations.

Materials: Cold-rolled steel or spring steel.

Sizes: No. 6 to $\frac{7}{16}$-in.; sheet metal screw threads. Body styles include light, heavy-duty and stud types.

Source: Prestole Corp., Toledo, O.

Speed Nuts

Form: One-piece, all-metal free-spinning locknut made as stamping. Compression of arched base coupled with inward gripping pressure of two arched prongs on screw thread produces secure locking action as nut is seated.

Design Features: Reusable. Resists loosening effect of vibration. Adaptable to high-speed assembly techniques. Locking action compensates for thread tolerance variations. Provides low-cost, high-production, vibration-resistant locking fastener.

Materials: Heat-treated spring steel.

Sizes: No. 2 to ⅝-in.; machine screw, sheet-metal screw and Acme bolt threads. Body styles include flat, W, J, U, anchor, latch and many other types.

Source: Tinnerman Products Inc., Cleveland.

Spin-Lock Nut

Form: One-piece, all-metal, free-spinning locknut. Ratchet-like teeth on outer edge of enlarged nut base become embedded in part surface when nut is seated.

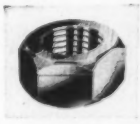
Design Features: Reusable. Design of locking teeth facilitates tightening but resists loosening. Resists extreme vibration. Adaptable to high-speed assembly techniques. Can take higher tightening torque than standard machine screw nut. Provides low-cost, rapidly assembled vibration-resistant locknut.

Materials: Carburized steel.

Sizes: No. 8 to ⅜-in.; Coarse and Fine threads, Class 2B. Body style is hex.

Source: Russell, Burdsall & Ward Bolt and Nut Co., Port Chester, N. Y.

Stover Locknut



Form: One-piece, all-metal, prevailing-torque locknut. Top portion of nut is compressed so that upper threads are elliptical while bottom part remains circular. Distorted section produces firm, positive locking grip on bolt.

Design Features: Reusable. Can be started by hand; then tightened with wrench. Provides strong vibration-resistant locking action even when bolts do not protrude through nut.

Materials: Steel.

Sizes: ¼ to 2 in.; UNC and UNF threads. Body styles include regular, thin and thick.

Source: The Lamson & Sessions Co., Cleveland.

Triangular Nut

Form: One piece, all-metal free-spinning locknut made as stamping. Nut body is dished. Spring clamping action of edges of circular opening provides firm locking grip on screw when nut is seated.

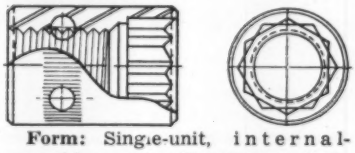
Design Features: Reusable. Resists impact and vibration. Dished body flattens under torque, providing equal load distribution against part to be held. Can be adapted to high-speed assembly methods. Provides low-cost, high-production locknut for lightly loaded assemblies.

Materials: Carbon spring steel.

Sizes: No. 6 to ¼-in.; Coarse and Fine threads.

Source: Waldes Kohinoor Inc., Long Island City, N. Y.

Unbrako Locknut



Form: Single-unit, internal-wrenching, prevailing-torque locknut. Two nonmetallic plugs in threaded section of nut contact four threads of bolt to provide firm locking friction grip.

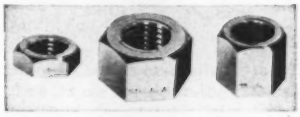
Design Features: Reusable. Designed primarily as a safety nut for primary connections in aircraft. Provides internal-wrenching features and has long threaded section for maximum safety.

Materials: Heat-treated steel.

Sizes: ¼ to 1¼-in.; NF threads.

Source: Standard Pressed Steel Co., Jenkintown, Pa.

Uni-Torque Locknut



Form: One-piece, all-metal, prevailing-torque locknut. Top threads of nut are deflected slightly out of true helix shape to produce binding friction lock on bolt.

Design Features: Reusable. Starts freely on bolt until deflected threads are reached, then is wrenched. Remains locked at any position on bolt when deflected threads are engaged. Finished nut size same as equivalent standard nut. Resists vibration and loosening torque loads.

Materials: Steel.

Sizes: ¼ to 2 in.; NC and NF threads, Class 2B. Body styles include full, jam and high hex.

Source: MacLean-Fogg Lock Nut Co., Chicago.

V-Lock Teenut

Form: One-piece, all-metal prevailing-torque locknut. Body of nut is in form of threaded sleeve with flanged base. Top of sleeve, which has V-shaped notch, is compressed inwardly to provide wedge locking action on engagement with threads of bolt.

Design Features: Reusable. Provides a secure, seated locknut or stop nut. Withstands vibration. Provides high strength-weight ratio. Maximum application temperature is 550 F.

Material: Low-carbon cold-rolled steel.

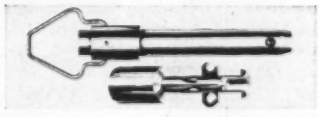
Sizes: No. 8 to ½-in.; UNC and UNF threads, Class 2B. Body styles include both locking and nonlocking types as well as many sleeve and flange designs.

Source: United-Carr Fastener Corp., Cambridge, Mass.

PINS

Several pin devices have been developed primarily for fastening applications. Where loading is mainly in shear and the required clinching force is small or negligible, they can often be employed to cost advantage. Other possibilities include multipurpose functions as a locking fastener and a hinge, shear pin, locating surface, retaining shoulder or bearing face. In addition to the pin types listed here, standard straight, dowel, tapered and clevis pins, which are basically locating surfaces, can often be adapted to fastening service.

Ball-Lok Quick-Release Pin



Form: Single-action type, quick-release locking pin assembly containing spring action plunger-and-ball locking mechanism. In locked position, balls protrude beyond diameter of pin shank to provide positive lock. When plunger is moved by means of button at end of pin, balls are released to permit insertion or removal of shank in prepared hole.

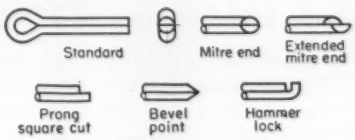
Design Features: All pins are single action, requiring either push or pull to remove. Pins are fastened to structure by chain or cable to prevent loss when disassembled. Requires no special tools for assembly or disassembly. Provides reliable quick-release fastener where frequent assembly and disassembly is required.

Materials: Pin is heat-treated steel; balls are chrome steel.

Sizes: ¼ to 1 in. pin diameters. Range of grip lengths.

Source: D. W. Price Corp., Los Angeles.

Cotter Pin



Form: One-piece, split cylindrical metal pin with loop formed at one end. Pin is inserted in hole and split ends are bent over to lock pin in place.

Design Features: Provides a retaining shoulder to hold parts in place on threaded or unthreaded stud or rod members. Used to lock clevis pins, castle nuts or slotted nuts in position. Diameter of inside loop is approximately the same as pin diameter.

Materials: Mild steel, brass, bronze, stainless steel and aluminum.

Sizes: 0.031 to 0.750-in. nominal pin diameters. Body styles include square, mitre, prong, bevel and hammer lock end shapes.

Source: American Standard *Machine Pins*—ASA B5.20-1954.

Groove Pins

Form: Cylindrical metal pin with three or four longitudinal surface grooves pressed or rolled into its surface. When pin is forced into prepared hole, elastic deformation

of grooves develops radial forces to lock pin in position.

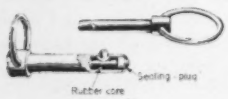
Design Features: Provides force fit in hole. May be reused many times without appreciably affecting holding action. Can be installed with hammer or press and is adaptable to mass production methods. Eliminates need for tapping or reaming of taper or sized holes. Pin locks securely in drilled hole and is highly resistant to shock and vibration. Provides a low-cost headless locking fastener.

Materials: Cold-drawn steel.

Sizes: $\frac{3}{64}$ to ½-in. nominal pin diameters. Lengths from ⅛ to 4½ in. Pin styles include several groove and spring anchor types.

Source: (Driv-Lok) Drive-Lok Pin Co., Sycamore, Ill.; (Gillen) John Gillen Co. Inc., Cicero, Ill.; (Groov-Pin) Groov-Pin Corp., Ridgefield, N. J. Photo, courtesy Groov-Pin Corp.

Harley Quick-Release Pin



Form: Solid-shank, quick-release locking pin assembly containing rubber core and locking lug. Lug projects from surface of pin shank until sufficient force is applied in assembly or removal to cause lug to retract against spring action of rubber core and release pin for movement.

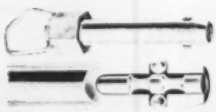
Design Features: Provides positive attachment with easy removal. Release "pull-off" load ranges from 4 to 50 lb, depending on size of pin and hardness of rubber core material. Solid shank construction of pin develops full shear strength of pin material. Used primarily as shear pin, but can also be utilized as a lock pin.

Materials: Pin is high-tensile steel or stainless steel. Rubber core is 70 durometer buna-N-rubber or neoprene. Locking lug is case hardened mild steel.

Sizes: ¼ to 1¼ in. pin diameters. Lengths from 0.9 to 3 in.

Source: Harley Patents Inc., New York.

Pip Quick-Release Pin



Form: Quick-release locking pin fastener assembly containing spring-loaded plunger-and-ball locking mechanism. In normal position, balls protrude beyond diameter of pin shank to provide positive lock. Balls are released to permit insertion and removal of pin from prepared hole by pushing or pulling button at end of pin.

Design Features: Requires no special assembly tools. Facilitates assembly and servicing operations and provides for emergency release. Pins are designed primarily for shear loading although they will withstand considerable tensile force. Holes are reamed to nominal pin diameter to give free fit. Provides dependable, quick-release fastener.

Materials: Heat-treated chrome-moly steel.

Sizes: ¼ to 1 in. pin diameters. Grip lengths from 0.2-in. up.

Source: Aviation Developments Inc., Burbank, Calif.

Spirol Pin

Form: Hollow cylindrical pin made of spiral-wound metal strip. When pin is driven into prepared hole of smaller diameter, spring action of coils locks it in place.

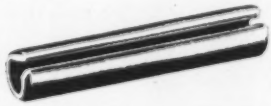
Design Features: Reusable. Strength and locking properties of pin can be readily changed by varying coil construction. Eliminates need for precision drilling and reaming of holes. Can be used in soft or brittle materials without damaging holes or cracking material. Provides lightweight, headless fastener with high resistance to shock and vibration loads.

Materials: Heat-treated carbon steel or heat-treated or unheat-treated stainless steel.

Sizes: 0.020 to ½-in. nominal pin diameters. Lengths from ⅛ to 4 in.

Source: C.E.M. Co., Danielson, Conn.

Spring Pin



Form: Slotted, hollow cylindrical pin. When pin is driven into prepared hole of slightly smaller diameter, spring action of walls locks it in place.

Design Features: Reusable. Fits flush. Resists loosening effect of vibration and wear. Eliminates need for reaming or tapering of holes. Can be inserted by hand or machine. Pin is lighter than solid mild carbon steel pin, yet has greater shear strength. Hollow construction permits "doubling-up" of pins for greater strength. Provides low-cost, lightweight, headless fastener with high shear strength.

Materials: Carbon and corrosion-resistant steel and beryllium copper.

Sizes: 0.062 to ½-in. nominal pin diameters. Lengths from $\frac{3}{16}$ to 5½ in.

Source: (Rollpin) Elastic Stop Nut Corp. of America, Union, N. J.; (Sel-Lok) Standard Pressed Steel Co., Jenkintown, Pa. Photo, courtesy Elastic Stop Nut Corp. of America.

RETAINING RINGS

Basic function of retaining or, as they are sometimes called, snap rings is to provide a shoulder for retaining, locking or positioning components on shaft, stud or pin members and in housing bores. Need for costly machining or grinding of shoulders from stock is thus eliminated, with subsequent gains in ease of assembly and disassembly. Application possibilities include both rotating and nonrotating service.

Retaining rings presented here are, in general, representative of types presently available. In certain cases, however, similar products are also produced by other manufacturers.

Connor Spring Clips

Form: Precision-formed wire "hairpin" shaft clips. Clips snap into annular groove on shaft or pin with ends projecting beyond shaft surface.

Design Features: Will rotate within specified circumference. Can be applied or removed with pliers. Used to fasten rotating or nonrotating parts on small shafts in office equipment, instruments, etc.

Materials: High tensile music

wire.

Sizes: ⅛ to ¼-in. nominal shaft diameters.

Source: Connor Spring Mfg. Co., San Francisco.

National Retaining Rings

Form: Split, one-turn, formed retaining ring. Ring is mounted in annular groove in shaft or housing bore.

Design Features: Eliminates need for machining or grinding of shaft stock to form shoulders. Simplifies assembly of components on shafts and pins or in housing bores.

Materials: Heat-treated carbon spring steel.

Sizes: $\frac{3}{16}$ to 3 in. nominal shaft diameters.

Source: The National Lock Washer Co., Newark, N. J.

Plasti-Ring

Form: Plastic ring of circular cross-section. Rolled into annular groove on shaft or pin, ring partially projects above surface.

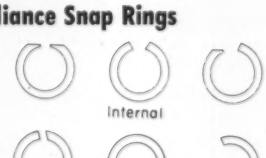
Design Features: Provides low-cost, lightweight shoulder for small machine shafts. Resists vibration, friction and wear, and can withstand up to 250 pounds direct shear force.

Materials: Injection-molded, white vinyl plastic.

Sizes: ⅛ to 1 in. nominal shaft diameters.

Source: Fastex Div. of Illinois Tool Works, Des Plaines, Ill.

Reliance Snap Rings



Form: Split, one-turn, uniform-section retaining ring formed from hard drawn wire. Ring is mounted in annular groove in shaft or housing bore.

Design Features: Provides a tight groove fit at assembly. For shoulder applications, ring is designed to withstand predetermined thrust load.

Materials: Cold-drawn spring steel wire.

Sizes: ⅛ to 7.8740 in. shaft diameters; 1.1811 to 7.8740 bore diameters. Ring types include open or closed gap with several different cross section shapes.

Source: Reliance Div., Eaton Mfg. Co., Massillon, O.

Spirolox Retaining Rings

Form: Two-turn, flat, formed retaining ring. Ring is installed in annular groove in shaft or housing bore.

Design Features: Can be installed or removed without special tools. Performance of ring does not depend upon inherent gripping power against bottom of groove. Locks automatically in groove under thrust. Does not lose circularity or holding power on removal and can be reused.

Materials: Hardened and tempered high-carbon spring steel.

Sizes: ½ to 11 in. nominal shaft diameters.

Source: Spirolox Div., Ramsey Corp., St. Louis.

Springrip Washer

Form: Dished metal washer with teeth on inside diameter. Washer locks in place when pushed onto a stud, pin or shaft.

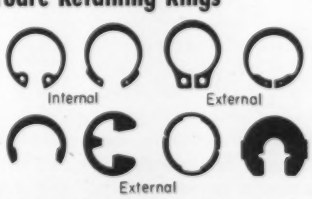
Design Features: When washer is pushed into position on stud or shaft, teeth engage surface around full circumference to achieve high locking power. Used to fasten rotating or nonrotating parts to shafts, axles or studs of steel, aluminum, zinc, magnesium and plastic.

Materials: Heat-treated high-carbon steel.

Sizes: $\frac{3}{32}$ to $\frac{5}{8}$-in. nominal diameters. Body styles include internal type for use in drilled or bored holes.

Source: Fastex Div. of Illinois Tool Works, Des Plaines, Ill.

Truarc Retaining Rings



Form: Stamped metal retaining rings. Rings are mounted in annular groove in shaft or housing bore.

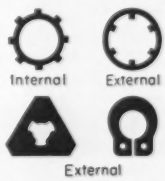
Design Features: Hardened ring will take about twice as much static thrust as groove cut in mild steel. Lug construction at ends of rings facilitates assembly and removal. Can accommodate diameter variations, permitting wide tolerance range on groove dimensions. Some of smaller external ring sizes can be adapted to high-production assembly methods.

Materials: Carbon spring steel and beryllium copper.

Sizes: 0.040 to 10 in. nominal shaft diameters; 0.250 to 10 in. nominal bore diameters.

Source: Waldes Kohinoor Inc., Long Island City, N. Y.

Truarc Self-locking Rings



Form: Stamped metal retaining rings. Installed on ungrooved surface of shaft or housing bore, rings grip surface under spring action to lock ring in place.

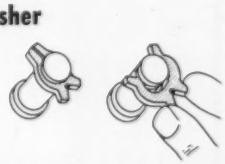
Design Features: Will withstand moderate thrust, impact or vibrational loads. Can be installed in shallow groove to increase holding power.

Materials: Carbon spring steel and beryllium copper.

Sizes: 0.062 to 1 in. nominal shaft diameters; 0.312 to 2.0 in. nominal bore diameters.

Source: Waldes Kohinoor Inc., Long Island City, N. Y.

X-Washer



Form: Split, one-piece washer with projecting ears. Washer is clamped in place in annular groove on pin.

Design Features: Can be readily installed by hand or with pliers. Closure is positive over 360 degrees. Permits quick disassembly. Used as locking shoulder on pins or small shafts.

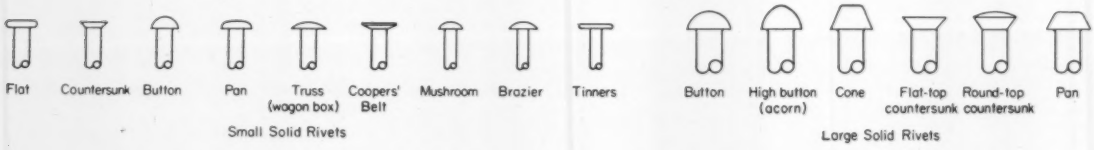
Materials: Cold-rolled steel.

Sizes: 0.085 to ¼-in. nominal pin diameters.

Source: Standard Locknut and Lockwasher Inc., Indianapolis.

RIVETS

Rivets offer two primary attributes. They can readily be adapted to high-speed assembly techniques and they provide a permanent attachment. Properly applied, the driven rivet produces a neat, sound joint with high strength-weight characteristics. Basically an old technique, riveting has seen wide use in aircraft. Correspondingly, potential uses today have been extended to include a wide range of assembly requirements in the design of both light and heavy-duty equipment for industrial and domestic service.



Bifurcated (Split) Rivet

Form: One-piece metal rivet with a two-prong shank formed by sawing or punching solid rivet. Rivet is driven through material to be fastened and clinched against a solid form that bends back prongs and presses them into work.

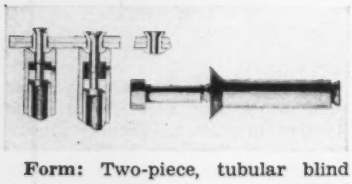
Design Features: Provides low-cost, high-production permanent fastener for joining light-gage metals, or fibre, wood and plastic materials. Since rivet is self-piercing, need for separate hole-forming operation is eliminated. Can be capped to prevent clinch from tearing material and to improve appearance and strength.

Materials: Steel, aluminum or brass.

Sizes: 0.080 to 3/16-in. nominal shank diameters. Shank lengths from 3/16-in. up. Head styles include oval, truss and countersunk.

Source: Produced by several manufacturers. Illustration, courtesy Milford Rivet & Machine Co., Milford, Conn.

Cherry Pull-Through Rivet



Form: Two-piece, tubular blind rivet consisting of a preassembled hollow rivet on a pull stem. Rivet is set by pulling stem through rivet shank. Upsetting head on end of stem forms "tulip head" in blind end of rivet. When blind head is tightly formed against part, upsetting head partially collapses and continues through rivet, expanding shank.

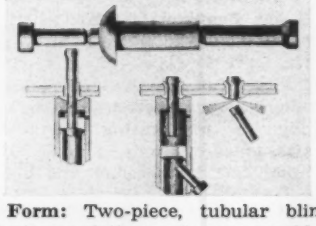
Design Features: Provides positive shank expansion. Clinch is comparable to solid rivet. Material spoilage is reduced, since clinching is by a pulling action. Pulling head of rivet tool does not come in contact with assembly parts and will not mar surfaces or shatter brittle materials. Rivet hole can be filled with an umbrella or plain plug where closed assembly is required. Used for rapid assembly in blind or open locations where high shear strength of self-plugging type is not required.

Materials: Aluminum, mild steel or Monel.

Sizes: ⅛ to 9/32-in. nominal diameters. Grip lengths from 1/16 to ¾-in. Head styles include brazier, countersunk and modified truss.

Source: Townsend Co., New Brighton, Pa.

Cherry Self-Plugging Rivet



Form: Two-piece, tubular blind rivet consisting of preassembled hollow rivet on pull stem. Enlarged portion of stem is first pulled into rivet, expanding shank to fill hole. Conical tip on stem then upsets blind head. Continued pull fractures stem, leaving rivet with protruding end which is trimmed flush to rivet head with hand or power trimmers.

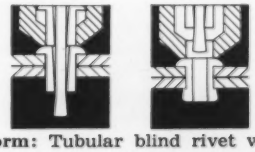
Design Features: Driven rivet has properties closely similar to those of solid rivet. Material spoilage is reduced since clinching is by pulling action. Pulling head of rivet-tool does not come in contact with assembly parts and will not mar surfaces or shatter brittle materials. In use, rivet pulls up tight, resists vibration, and provides tamper-proof fastening. Used for rapid assembly in blind or open locations where high shear strength is required.

Materials: Aluminum, mild steel or Monel.

Sizes: ⅛ to 9/32-in. nominal diameters. Grip lengths from 1/16 to ¾-in. Head styles include brazier, countersunk and modified truss.

Source: Townsend Co., New Brighton, Pa.

Chobert Rivet



Form: Tubular blind rivet which is upset by drawing flared mandrel through tapered hole in shank.

Design Features: Mandrel is reused. Rivet setting can be manual, or automatic by hand gun or machine at rates up to 2000 per hr. Rivet hole can be plugged with sealing pin where greater shear strength or gas and liquid-tight sealing are desired. Used for low or high-speed riveting in blind or open locations.

Materials: Aluminum, mild steel, or Monel.

Sizes: 3/32 to ½-in. nominal diameters. Various grip lengths.

Source: Aviation Developments Inc., Burbank, Calif.

Compression (Cutlery) Rivet

Form: Two-piece rivet assembly consisting of a deep-drilled and a solid rivet. Deep-drilled rivet is inserted in counterbored hole and solid rivet is pressed into tubular shank. Diameter of solid shank and drilled hole are selected to develop a tight compression fit.

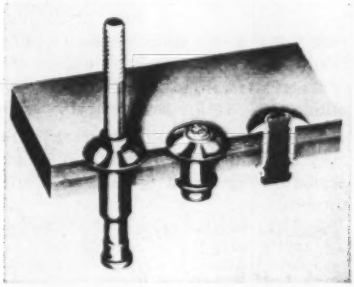
Design Features: Provides a low-cost, high production permanent fastener for light assemblies where a flush surface fit is required. Heads of both rivets can readily be matched for appearance purposes. Assembly pressure can be controlled to prevent splitting of wood or plastic parts.

Materials: Steel, brass, aluminum or other materials.

Sizes: 0.172 and 0.216 nominal hole diameters. Various grip lengths. Head style is flat.

Source: Produced by several manufacturers. Illustration, courtesy Milford Rivet & Machine Co., Milford, Conn.

Conical Keystone Lock Rivet



Form: Two-piece, tubular blind rivet consisting of preassembled sleeve and pin. In driving operation, sleeve is expanded by pin to fill hole. Sleeve end is upset into bulbed head and positive mechanical keystone lock is formed at rivet head. Tail of pin breaks off automatically when rivet is completely driven.

Design Features: Driven rivet is essentially mechanical equivalent of one-piece solid rivet of same shear strength, regardless of part thickness. Positive mechanical locking action prevents pin working free under vibration or fatigue loads even when rivet hole is oversize. Bulb forming operation causes assembly members to be tightly compressed and assures high strength and rigidity. Positive inspection of joint is possible from driving side. Particularly suited to high-speed automatic assembly operations in blind or open locations.

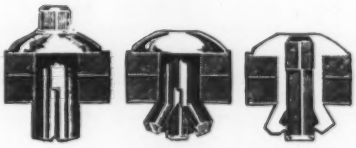
Materials: Aluminum.

Sizes: 1/8, 5/32 and 3/16-in. nominal diameters. Various grip lengths. Head styles include brazier and countersunk.

Source: Huck Mfg. Co., Detroit.

Deutsch Commercial Rivet

Form: Two-piece tubular blind rivet consisting of preassembled sleeve and expander pin. Driving pin into sleeve expands three prongs



on blind side to form blind head. Pin is permanently locked in place by peening lip on driving face of rivet sleeve over end of pin after driving.

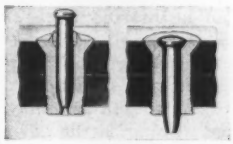
Design Features: Rivet is readily driven from one side with hammer. Positive pin lock formed by peened lip on sleeve resists loosening by vibration. Suitable for blind or open locations in structures capable of withstanding required rivet driving forces.

Materials: Sleeve is aluminum; pin is steel or stainless steel.

Sizes: 1/8 to 1/4-in. nominal diameters. Various grip lengths. Head styles include modified and full brazier and countersunk.

Source: The Deutsch Co., Los Angeles.

Deutsch Drive Pin Rivet



Form: Two-piece tubular blind rivet consisting of preassembled pin and sleeve (formerly known as Barker blind rivet). Rivet is set by driving pin into tapered hole at blind end of sleeve to form blind head. Lip section on driving end of sleeve is then peened over to lock pin in place.

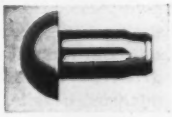
Design Features: Rivet is readily driven from one side with hammer. Provides high shear and tensile strength. Blind head provides positive liquid seal. Resists heat and corrosion and is light in weight. Used primarily in buried rivet applications, double construction or where a simple, strong, blind rivet is needed and structure is heavy enough to support required rivet driving forces.

Materials: Stainless steel.

Sizes: 3/16 to 3/8-in. nominal diameters. Various grip lengths. Head styles include countersunk and brazier.

Source: The Deutsch Co., Los Angeles.

Drive Studs



Form: Headed cylindrical pin with three or four longitudinal surface grooves in shank. When stud is driven into prepared hole, elastic deformation of grooves develops radial forces to lock shank in position.

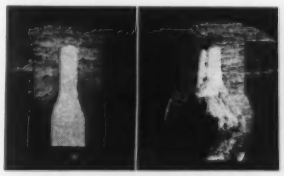
Design Features: Can be quickly installed with hammer blow. Resists vibration forces and can be removed easily without damage to assembly. Can be reused without appreciably affecting locking action. Used as headed fastener in blind or open locations to attach covers, name plates, conduit clamps or spring assemblies to cast iron, steel or other materials.

Material: Steel.

Sizes: 0.067 to 1/4-in. shank diameters. Lengths from 1/8 to 3/4-in. Head style is round.

Source: Driv-Lok Pin Co., Sycamore, Ill.; Groov-Pin Corp., Ridgefield, N. J. Illustration, courtesy Groov-Pin Corp.

Dupont Rivet



Form: One-piece tubular rivet containing a chemical charge which runs length of shank. Application of heat to rivet head activates charge, setting rivet almost instantaneously.

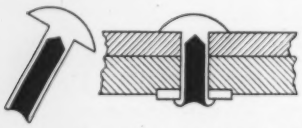
Design Features: Simplify fabrication operation. Setting is always accomplished from head side, using an electrically heated setting iron or similar tool. Shank expands to fill hole completely, insuring tight contact throughout thickness of joint. Sealed type rivet, which has plugged end, will not deform opposite or adjacent members located close to charge end when expanded, and is practically "noiseless" when being set. Range of grip length variation for some rivets may run to 1/8-in. Suitable for use in blind or open locations, and where space limitations for rivet assembly are severe.

Materials: Aluminum, superalloy, nickel alloy or brass.

Sizes: 1/8 to 1/4-in. nominal diameters. Various grip lengths. Body styles include sealed (noiseless) or regular open types with modified brazier or countersunk head construction.

Source: E. I. duPont de Nemours & Co., Inc., Wilmington, Del.

Full-Tubular Rivet



Form: One-piece metal rivet with a cavity extending almost full length of shank. Rivet is driven through material to be fastened and clinched with an anvil in rivet-setting machine.

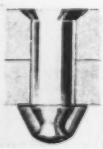
Design Features: Provides a low-cost, high-production permanent fastener for assembling materials such as leather, plastic sheet, wood and fabric. Since rivet is self-piercing, need for separate hole-forming operation is eliminated. Can be used with a cap, which acts as a washer to prevent clinch from tearing material and improves appearance and strength.

Materials: Steel, aluminum, brass, copper or iron.

Sizes: 9/64, 3/16-in. and other shank diameters. Various grip lengths. Head styles include oval, truss, countersunk and flat.

Source: Produced by several manufacturers. Illustration, courtesy Milford Rivet & Machine Co., Milford, Conn.

Hi-Shear Rivet



Form: Two-piece, solid rivet assembly consisting of hard, heat-treated, headed pin and softer, malleable metal collar. End of pin shank has narrowed section. Pin is placed in hole and collar is formed over narrowed section of shank by special gun or tool that draws parts tightly together.

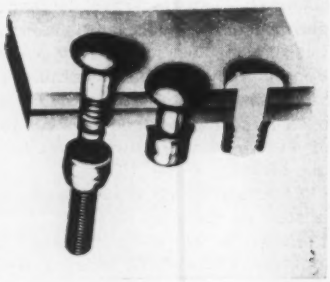
Design Features: Combines drivability of "soft" metal and shear strength of cold steel rivets with no loss in holding power. Can accommodate grip length variations up to 1/16-in.; surplus collar material is automatically trimmed when rivet is set. Used where a solid rivet is required with shear strengths in excess of those normally possible with standard rivets.

Materials: Pin is heat-treated alloy steel, corrosion-resistant steel, aluminum, titanium or Haynes 25; collar is aluminum, low-carbon steel, corrosion-resistant steel or Monel.

Sizes: ⅛ to ⅝-in. nominal diameters. Grip lengths 3/16 to 2½ in. Head styles include flat, countersunk and others.

Source: Pheoll Mfg. Co., Chicago, Ill.

Huckbolt



Form: Two-piece fastener assembly with features of both bolt and rivet. It consists of headed, grooved pin and locking collar that is swaged over grooves to lock the assembly. In assembly operation, pin is inserted from one side and collar slipped on from other. Jaws of pulling gun grip pull-grooves on pin, developing necessary tension to pull assembly pieces together. Collar is then swaged in locked position and continued pull by gun jaws separates pin tail at end of locking grooves.

Design Features: Provides permanent, rigid fastener that is resistant to vibration. Can be readily adapted to high-speed production methods. Has high shear, tension and fatigue strengths. Can be employed on curved or slanted surfaces. Provides hole filling when desired and develops effective seal. Pulls assembly pieces together, eliminating need for accurate prefitting and assuring uniform tightening.

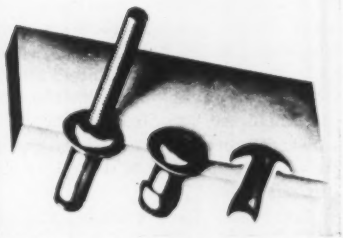
Materials: Pins are mild steel, heat-treated alloy steel, or aluminum; collars are mild steel or aluminum.

Sizes: 5/32 to ½-in. nominal diameters. Various grip lengths. Body types include a stump version for inaccesible locations. Head styles include brazier, button and countersunk.

Source: Huck Mfg. Co., Detroit.

Huck Pull-Through Rivet

Form: Two-piece, tubular blind rivet consisting of preassembled hollow rivet and cup-headed pin with pull grooves. Rivet is set by pulling pin through hole, forming



blind head first and then expanding shank to fill hole.

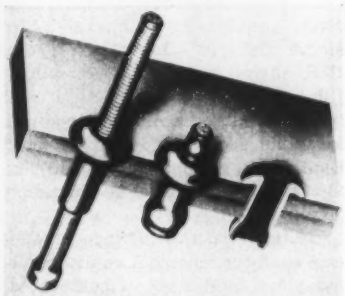
Design Features: Provides low-cost blind rivet with good shear and tensile strength properties. Driven rivet fills hole and has good assembly pull-together characteristics. Suitable for rapid assembly in blind or open locations. Typical uses include joining hollow tubing to fabricated parts and attaching electronic parts to chassis in difficult locations.

Materials: Steel, brass or aluminum.

Sizes: ⅛ to ¼-in. nominal diameters. Various grip lengths. Head styles include brazier, flat and countersunk.

Source: Huck Mfg. Co., Detroit.

Huck Self-Plugging Rivet



Form: Two-piece tubular blind rivet consisting of preassembled hollow rivet and headed pin with pull grooves. When driven, pin shank fills hole and expands rivet to form blind head. Further driving breaks off tail of pin.

Design Features: Low-cost blind rivet with large grip range. Driven rivet has approximately strength of equivalent solid aluminum or steel rivet. Provides rapid asembly in blind or open locations.

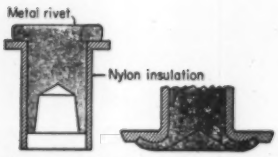
Materials: Aluminum or mild steel.

Sizes: ⅛ to ¼-in. nominal diameters. Various grip lengths. Head styles include brazier, flat, and countersunk.

Source: Huck Mfg. Co., Detroit.

Insulet Rivet

Form: Semitubular, flat-head, metal rivet in which shank section and under-the-head surfaces have



been covered with a uniformly thick plastic insulation. When tubular shank of rivet is upset by conventional methods, plastic stretches and spreads out in uniform layer under metal.

Design Features: Driven rivet provides secure electrically insulated joint. Wall thickness of plastic insulation is 0.015 in. Primary use is in electrical assemblies to fasten two isolated electrical conductors to common insulated base or to attach insulated metal components to metal frame. Also used to rivet ceramics or glass (the plastic sheath acts as a shock absorber to prevent cracking) or to provide air-tight and water-tight assembly joints.

Materials: Rivet is aluminum, brass or steel; insulation layer is nylon.

Sizes: 3/32 to 3/16-in. nominal diameters. Shank lengths from ⅛ to ¼-in.

Source: Pylon Co. Inc., Attleboro, Mass.

Olympic Drive Rivet

Form: Two-piece, tubular blind rivet consisting of preassembled grooved drive pin mounted in hole in head of rivet with slotted shank. Rivet is set by driving pin into shank to expand slotted-end segments.

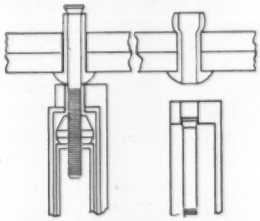
Design Features: Rivet is readily installed from one side, using hammer. Expanded shank segments produce tight grip on assembly members. Head of pin fits flush with head of rivet. Suitable for application in blind or open locations where material is sufficiently rigid to withstand driving force required.

Materials: Rivet body is aluminum; pin is aluminum, carbon steel or corrosion-resistant steel.

Sizes: ⅛ to ¼-in. nominal diameters. Grip lengths from 1/16 to 1 in. Head styles include brazier, countersunk and large modified truss.

Source: Olympic Screw & Rivet Corp., Downey, Calif.

Olympic Pull-Through Rivet



Form: Two-piece, tubular blind rivet consisting of preassembled hollow, free-spinning rivet on pull stem. Rivet is set by pulling stem through hole in rivet. Enlarged upsetting head on stem forms blind head, clinches assembly members, and then collapses as it passes through rivet.

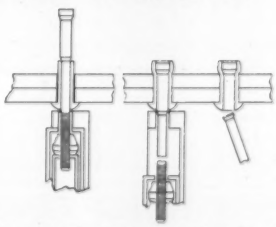
Design Features: Driven rivet is comparable to conventional hollow rivet in strength, configuration, permanence, and resistance to vibration. Provides high clinching action, and can be applied to highly finished surfaces without marring. Is self-aligning. Large shank expansion possible eliminates need for additional predrilling or reaming. Rivet can be plugged for strength, appearance or other reasons. Designed for use where rivet is not highly stressed; provides rapid assembly in blind or open locations.

Materials: Aluminum, mild or alloy steel, or Monel.

Sizes: 3/32 to 9/32-in. nominal diameters. Grip lengths from 1/16 to 1¼ in. Several head styles.

Source: Olympic Screw & Rivet Corp., Downey, Calif.

Olympic Self-Plugging Rivet



Form: Two-piece, tubular blind rivet consisting of preassembled hollow, free-spinning rivet on pull stem. Rivet is set by pulling stem through hole in rivet. Enlarged plug section on stem expands and upsets hollow rivet shank forming barrel-shaped blind head. Under continued pull, stem breaks at preformed notch, releasing setting tool.

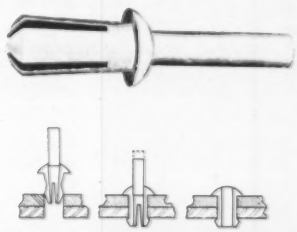
Design Features: Driven rivet is comparable to conventional solid rivet in strength, configuration, permanence, and resistance to vibration. Has low deflection factor for greater safety in highly stressed locations. Can be applied to highly finished surfaces without marring. Is self-aligning. Large shank expansion possible eliminates need for additional predrilling or reaming. Permits rapid assembly in blind or open locations.

Materials: Aluminum, mild or alloy steel, or Monel.

Sizes: 3/32 to 9/32-in. nominal diameters. Grip lengths from 1/16 to 1¼ in. Several head styles.

Source: Olympic Screw & Rivet Corp., Downey, Calif.

Plasti-Rivet



Form: One-piece, self-expanding, plastic blind rivet. Projecting pin on driving side is released from its plastic collar and driven into rivet shank by blow. Prongs on blind end of shank are expanded by pin to provide positive locking action.

Design Features: Expansion gripping action resists loosening effects of vibration. Driven rivet is nonconductive, stable over wide temperature range, and corrosion resistant. Each rivet provides range of grip lengths. Permits rapid assembly in blind or open locations. Uses include metal-to-plastic joining, clock mounting, hinge fastening and name plate attachment.

Materials: Thermoplastic compositions (nylon, acetate, butyrate, polystyrene or polyethylene).

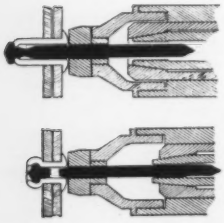
Sizes: ⅛ to ⅜-in. nominal diameters. Grip lengths from 1/64 to ⅝-in. Head styles include round, countersunk and truss.

Source: Fastex Div. of Illinois Tool Works, Des Plaines, Ill.

Pop Rivet

Form: Two-piece tubular blind rivet consisting of preassembled hollow rivet and headed mandrel. Special gun grips and pulls mandrel to clinch rivet. Continued pull breaks mandrel, which then comes free.

Design Features: High-produc-



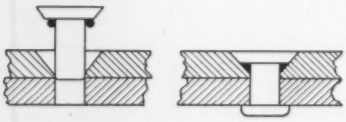
tion fastener with large grip range. Two mandrel types used: with break-head mandrel, head pops off and falls clear inside structure; with break-stem mandrel, head is retained in rivet and stem pulls free. Rivets can be weather-proofed with sealing cap, or filled with sealing compound. Normally, sealing action of retained head in rivet is sufficient. Strength of hollow Monel rivet is equivalent to conventional solid aluminum rivet. Used primarily for high-speed metal fabrication in open or blind locations.

Materials: Monel or aluminum.

Sizes: 7/64 to 0.200-in. nominal diameters. Several grip lengths. Head styles include domed and countersunk.

Source: Pop Rivet Div., United Shoe Machinery Corp., West Medway, Mass.

Riv-O-Seal



Form: Preassembled, flush-head solid rivet and O-ring. When rivet is set by conventional methods, round cross section of O-ring changes to triangular shape to fill controlled void under rivet head.

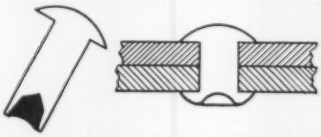
Design Features: Rivet design is based on principle of controlled confinement of rubber and provides positive seal which is effective under high and low pressure. Simplifies flush rivet sealing problems and eliminates need for sealing "pastes." Particularly suited to applications where sealed flush rivet is required.

Materials: Rivet is aluminum; O-ring is silicone or black nitrile rubber.

Sizes: 3/32 to 5/16-in. nominal diameters. Grip lengths from 0.040 to 0.125 in. Head style is countersunk.

Source: Franklin C. Wolfe Co. Inc., Culver City, Calif.

Semitubular Rivet



Form: One-piece, solid metal rivet with shallow drilled or extruded hole in end of shank. Hole depth does not usually exceed shank diameter Rivet is inserted in prepared hole and clinched with anvil in rivet-setting machine.

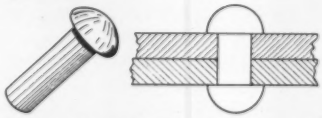
Design Features: Provides a low-cost, high-production fastener for light assemblies. Hole in end of shank facilitates clinching. Driven rivet has shear and compression strength equal to comparable solid rivet.

Materials: Steel, aluminum, brass, stainless steel or copper.

Sizes: 0.058 to 5/16-in. shank diameters. Shank lengths from 3/16-in. up. Head styles include oval, truss and countersunk.

Source: Produced by several manufacturers. Illustration, courtesy Milford Rivet & Machine Co., Milford, Conn.

Solid Rivets



Form: Standard one-piece, solid metal rivets. Rivet shank is inserted in prepared hole and head is hot or cold formed on shank end with a set or forming tool. Setting can be accomplished by hand or by hydraulic or pneumatic-operated driving equipment.

Design Features: Provides a simple, reliable, low-cost permanent fastener. Driven rivet has a neat appearance. Produces sound, uniform joints when properly driven.

Materials: Steel, brass, aluminum, corrosion-resistant steel or other materials.

Sizes: No. 14 to 7/16-in. nominal diameters for small rivets; ½ to 1¾ in. for large rivets. Head styles include flat, countersunk, button, pan, truss, tinners, coopers and belt for small rivets; button, high button (acorn), flat-top countersunk, round-top countersunk, cone and pan for large rivets.

Source: American Standard *Small Solid Rivets* — ASA B18.1-1955; American Standard *Large Solid Rivets* — ASA B18.4-1950.

Southco Drive Rivet

Form: Two-piece, tubular blind rivet consisting of preassembled slotted, cored rivet and steel grooved pin. Rivet is upset by driving pin into shank to expand prongs on blind side.

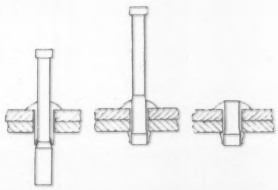
Design Features: Rivet shear strength is comparable to solid rivet. Formed blind head is reinforced by pin. Rivet can readily be installed with hammer; no finishing off is required. Pull-up action of expanding prongs draws parts tightly together. Metal flow produced by driving operation aids locking action. Particularly suited to blind and access locations in structures able to support driving forces.

Materials: Rivet body is steel or aluminum; pin is steel or stainless steel.

Sizes: ⅛ to ¼-in. nominal diameters. Grip lengths from 1/32 to ⅝-in. Head styles include modified brazier and countersunk.

Source: Southco Div., South Chester Corp., Lester, Pa.

Versa-Rivet



Form: Two-piece tubular blind rivet consisting of preassembled hollow rivet on pull stem. Enlarged portion of stem is pulled into rivet, upsetting blind head to draw parts up tight and expanding shank to fill hole. Distance travelled by stem in rivet is controlled by driving tool according to grip length required. Protruding stem ends are then trimmed flush with surface of rivet head.

Design Features: Driven rivet provides high clinching action, wide grip range, positive hole fill, and positive stem retention. Range of shank expansion can accommodate oversize holes, up to 0.035-in. oversize in some cases. Rivet tools do not touch part surface, eliminating possibility of assembly damage. Permits rapid assembly in blind or open locations.

Materials: Aluminum.

Sizes: ⅛ to ¼-in. nominal diameters. Maximum grip lengths from 3/16 to ⅜-in.

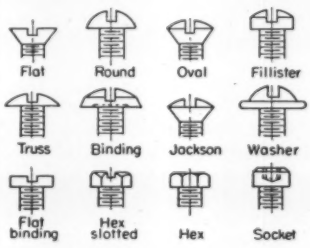
Source: Townsend Co., New Brighton, Pa.

SCREWS, BOLTS, STUDS

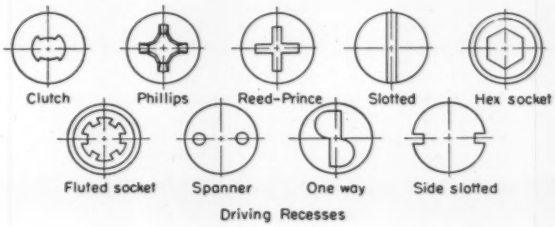
Of basic importance in design, screws, bolts and studs define a large family of externally threaded fasteners that offer practical advantages in ease of assembly and disassembly.

Making a distinction between each of the types is often difficult. Trade designations are frequently representative of old original usage and have been maintained for convenience. In general, a bolt is supplied with a nut. A screw is not.

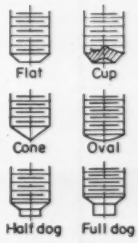
Many of the screw, bolt and stud types have been standardized. An even greater number have not. Types presented here are generally representative of both groups but do not include many special-purpose designs available from individual manufacturers.



Screw Heads



Driving Recesses



Set Screw Points

Absco Self-Sealing Screw

Form: Single-unit, self-sealing screw consisting of screw with thin Teflon washer and standard O-ring mounted in groove on bottom side of screw head. When screw is tightened, O-ring flows to provide seal and Teflon washer reduces friction between screw head and O-ring.

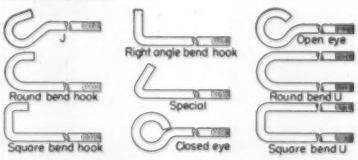
Design Features: Reusable. Design facilitates rapid assembly and does not require lubrication for installation. Eliminates separate handling of screw and sealant, as well as secondary operations. Can be used with oversize holes; screw head is one size over standard.

Materials: Screw is carbon or alloy steel, passivated corrosion-resistant steel, brass or aluminum; O-ring is synthetic rubber.

Sizes: No. 10 to ½-in.; NF and UNF threads; Class 3. Head styles include hex, round and countersunk.

Source: Aero Bolt & Screw Co. Inc., Inglewood, Calif.

Bent Bolts



Form: Threaded rods with special bent shank shapes.

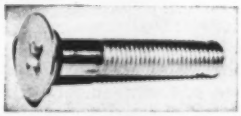
Design Features: Used in applications where a formed shank shape, rather than a standard head, is desired for assembly purposes.

Materials: Steel, brass, bronze, aluminum or stainless steel.

Sizes: All standard diameters; Coarse and Fine threads. Body styles include J, hook, eye and U.

Source: Industrial Fastener Institute Standard.

Bolt-O-Seal



Form: Flush-head bolt with special rubber seal built into bottom side of head. Design of seal is based on principle of controlled confinement of rubber and provides a positive sealing action when bolt is tightened.

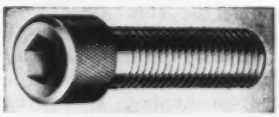
Design Features: Reusable. Provides a self-contained sealing bolt that can be used with most liquids and gases. No cold flow is developed in rubber, which keeps its elastic memory. Stress and strength factors are maintained by metal-to-metal contact of faying surfaces. Application temperature range is 100 to 375 F.

Materials: Bolt is high-strength steel; seal is white silicone or black nitrile rubber.

Sizes: No. 8-32 to ⅜-24. Head style is countersunk with Phillips recess.

Source: Franklin C. Wolfe Co., Inc., Culver City, Calif.

Cap Screws



Form: High-quality headed and threaded screw fastener. End of threaded shank has a chamfer point.

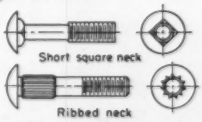
Design Features: Provides a general-purpose screw fastener for use in tapped holes. Used where a screw of high strength, fine tolerances or quality finish is required.

Materials: Heat-treated or alloy steel, brass, bronze, corrosion-resistant steel, aluminum and other materials.

Sizes: No. 0 to 1½ in. nominal diameters; Coarse, Fine and 8-thread series; Class 2A and 3A. Lengths from ⅜ to 6 in. Head styles include hex, flat, round, fillister and socket. Driving recesses include slotted and hex and fluted sockets.

Source: American Standard *Hexagon Head Cap Screws, Slotted Head Cap Screws, Square Head Set Screws, and Slotted Headless Set Screws*—ASA B.18.6.2-1956; American Standard *Socket Head Cap Screws and Socket Set Screws*—ASA B 18.3-1954.

Carriage Bolts



Form: Standard round-head bolts with square or ribbed neck shape to prevent rotation when nut is tightened. Square-neck type is mounted in a square punched hole; ribbed-neck type is driven into hole with an interference fit or staked in place.

Design Features: Used in applications where it is impractical to hold the bolt head while tightening the nut. Short square-neck type can be used in steel assemblies to fasten sheet-metal parts; it usually requires a mounting hole only in the first metal sheet under the head. Square-neck design is also useful

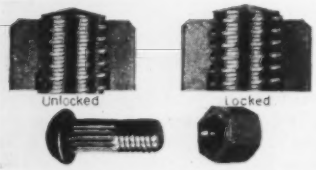
for fastening castings and forgings because of the tolerance permitted by its neck shape. Ribbed-neck type can be employed with plastic or other similar materials.

Materials: Steel.

Sizes: No. 10 to ¾-in. nominal diameters; Coarse threads; Class 2A. Lengths from ½-in. up. Head styles include several other neck shapes.

Source: American Standard *Round Head Bolts*—ASA B18.5-1952.

Dardelet Rivet Bolt



Form: All-metal, free-spinning, locking bolt assembly. Bolt consists of standard rivet head and shank which is axially ribbed at upper end and has special locking thread to receive mating nut. Bolt is driven into prepared hole, causing ribs to deform and grip hole wall to give body-bound fit. Nut is then applied and tightened against seating surface. Axial tightening force drives crest of nut thread along tapered root surface of bolt thread, producing a positive locking action when the point of maximum root diameter is reached.

Design Features: Nut turns down freely until seated, then is wrench tightened. Provides high shear and bearing strength, equal to power-driven rivets or turned bolts in reamed holes. Resists loosening under extreme shock and vibration conditions. Used in steel structures where a high-strength, easily assembled, seated locking bolt is required.

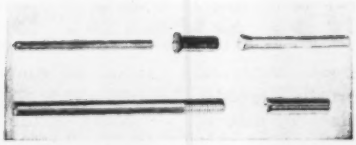
Materials: Steel.

Sizes: ⅜ to 1 in. nominal diameters. Lengths from ⅜ to 4 1/16 inches. Head styles include round and flat countersunk.

Source: Bethlehem Steel Co., Bethlehem, Pa.; The Lamson and Sessions Co., Cleveland. Photo, courtesy The Lamson and Sessions Co.

Graham Weld Studs

Form: Standard threaded studs with special weld tip. Studs are welded to the part surface by a stored energy process that produces instantaneous heating at the weld-



ing surfaces. Welding is completed by hammer blow imparted to the stud by the welding gun.

Design Features: Provides a permanent stud attachment that can be installed at high-speed. A strong weld is formed across the end of the stud without a fillet at the weld joint. Adjacent surface is not marred by the welding process even if it is plated, painted, or enameled.

Materials: Low-carbon ferrous compositions and other nonferrous metals.

Sizes: 0.060 to 5/16-in. nominal diameters.

Source: Graham Mfg. Corp., Royal Oak, Mich.

Hi-Torque Bolt

Form: High-strength, flat-head machine bolt with undercut, slotted driving recess that is wider at the periphery of the head than at the center. Bolt is tightened with a special driver using a relieved, disk-shaped bit.

Design Features: Can withstand high tightening torques. End thrust is not required to keep driving tool in position during tightening. Used primarily where torquing to a high preload is required.

Materials: Heat-treated alloy steel, corrosion-resistant steel or titanium.

Sizes: 3/16 to ⅝-in. nominal diameters; Fine threads. Various lengths.

Source: Pheoll Mfg. Co., Chicago.

Kelox Stud

Form: Two-piece, self-locking, tap-end type stud assembly consisting of stud and locking ring which has two keys extending from bottom surface. After stud is installed in tapped hole, ring is pressed into place at top of hole with keys extending down into mating axial grooves in stud thread. Keys cut through suficient threads in the tapped hole to provide a positive lock.

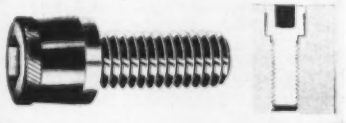
Design Features: Provides a secure, locked stud installation. Requires no special installation tools. Eliminates the need for special thread fits to obtain secure locking action.

Materials: Alloy steel.

Sizes: No. 6 to ½-in. nominal diameters for nut-end threads; No. 10 to ⅝-in. nominal diameters for tap-end threads; Coarse and Fine series; Class 3. Various lengths.

Source: Fasteners, Inc., New York.

Led-Lok Cap Screw



Form: Preassembled socket cap screw and lead washer. External surface of socket head has reverse taper with smallest diameter at top. As screw is tightened, washer extrudes into cavity along the sides of socket head formed by tapered shape. Wedge-shaped lead ring thus produced locks screw in place.

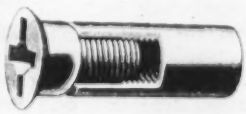
Design Features: Provides heavy-duty, flush-mounted locking fastener. Reusable when lead washer is replaced. Wedge-shaped lead ring provides fluid-tight seal around head. Locking action resists vibration.

Materials: Cap screw is heat-treated alloy steel.

Sizes: No. 4 to 1½-in.; NC and NF threads; Class 3.

Source: Safety Socket Screw Co., Chicago.

Lok-Rivet



Form: Two-piece, all-metal, locking bolt-type fastener, consisting of internally threaded sleeve nut and shouldered and headed screw member. As sleeve nut is tightened, it expands and flows over shouldered section to lock parts against head of screw member.

Design Features: Provides a rugged, long wearing, permanently fastened joint for sheet-metal parts or thin members. Positive locking action. Can be adapted to high-speed assembly methods. Has features of both bolt and rivet.

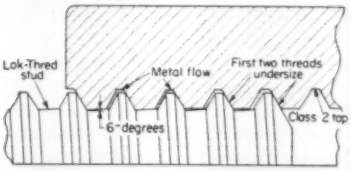
Materials: Steel or aluminum.

Sizes: 0.187 to 0.265-in. hole di-

ameters. Grip lengths from 0.010 to 0.365-in. Head styles include flush and flat.

Source: The Dill Mfg. Co., Cleveland.

Lok-Thred Fasteners



Form: Externally threaded fasteners employing modified American National thread form for prevailing-torque locking action. Thread form is used with socket having standard tapped threads. Modified thread has same 60-degree flank angle as American National thread but employs larger root diameter and a wider root surface which is tapered 6 degrees. Mating thread is reformed slightly in engagement, making possible locking on root along full length of contacting modified thread form. Metal of socket thread is placed under high compressive prestress.

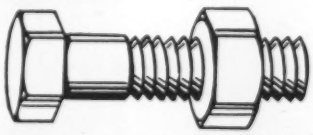
Design Features: Reusable. Provides control of installation torque. Mating thread can be formed with standard tools. Maintains secure locking action. Positive metal-to-metal contact of thread surfaces provides leak-tight sealing action.

Materials: All standard metals for threaded fasteners.

Sizes: No. 6 to 1 in.; Coarse and Fine threads. Fastener types include bolts, screws, studs and set screws.

Source: Lock Thread Corp., Detroit. Drawing, courtesy National Screw & Mfg. Corp., Cleveland.

Machine Bolts



Form: Standard headed and threaded bolts for use in through holes with hex, square or other appropriate mating nuts.

Design Features: Used for general-purpose fastening in all types of machinery and equipment. Hex-head bolts can be obtained in regular type for normal service or in heavy type for heavy loads and holes with large clearances.

Materials: Steel, brass, aluminum, stainless steel and other materials.

Sizes: No. 10 to 4 in. nominal diameters; Coarse, Fine and 8-thread series; Class 2A. Body styles include square, round and countersunk head as well as regular, semifinished and finished regular and heavy hex head.

Source: American Standard *Round Head Bolts*—ASA B18.5-1952; American Standard *Square and Hexagon Bolts and Nuts*—ASA B18.2-1955.

Machine Screws

Form: Standard-purpose, headed and threaded screw fastener. End of threaded shank is usually plain sheared, not pointed. When supplied with square nut, a machine screw becomes a stove bolt.

Design Features: Used for general-purpose fastening in tapped holes.

Materials: Steel, brass, aluminum, stainless steel and other materials.

Sizes: No. 0 to ¾-in. nominal diameters; Coarse and Fine threads; Class 2A. Lengths from ⅛ to 3 in. Head styles include round, flat, oval, fillister, truss, binding, pan and hex. Driving recesses include slotted, Phillips, Reed-Prince and others.

Source: American Standard *Slotted and Recessed Head Screws*—ASA B18.6-1947.

Metallic Drive Screws

Form: Type U American Standard tapping screw. Shank has multiple thread with large helix angle and dog point. Screws form mating thread when driven into prepared hole under pressure. Thread-forming action under pressure develops a strong locking grip.

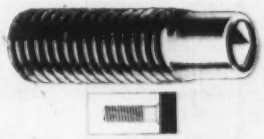
Design Features: Can be driven with hammer. Develops high holding power under tension and shear loading and will withstand severe vibration. Used as permanent fastener in heavy-gage sheet metals (0.050 to ½-in. thick), nonferrous castings and plastics.

Materials: Case-hardened steel.

Sizes: No. 00 to ⅜-in. nominal diameters. Lengths from ⅛ to 1 in. Body style is round head with flat dog point.

Source: American Standard *Slotted and Recessed Head Tapping Screws and Metallic Drive Screws*—ASA B 18.6.4.—(Tentative standard awaiting final approval).

Nelson Weld Studs



Form: Standard threaded stud with a weld tip containing granular flux. Stud is welded to the part by a modified electric arc process.

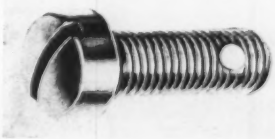
Design Features: Eliminates need for tapped holes. Provides a permanent stud attachment that can be installed at high speed. Minimum thickness of part to which stud can be welded is 0.020-in.

Materials: Low-carbon steel.

Sizes: ⅛ to 1 in. nominal diameters.

Source: Nelson Stud Welding, Div. of Gregory Industries Inc., Lorain, Ohio.

Nylok Self-Locking Screw



Form: Single-unit, prevailing-torque type, self-locking screw. Resilient nylon plug in threaded shank wedges screw threads tightly against mating threads to develop positive locking action.

Design Features: Reusable. Effectiveness of locking action increases with use due to "plastic memory" characteristic of nylon plug. Can be used as adjusting device. Nylon plug acts as dam to prevent leakage of fluid along threads. Working temperature range is −70 to 250 F.

Materials: Carbon steel, stainless steel, aluminum alloy, brass or bronze.

Sizes: No. 2-56 and larger; Commercial and aircraft grade threads. Body types include machine screw, socket-head cap screw, set screw and others.

Source: The Nylock Corp., Elmira Heights, N. Y.

Place Bolt

Form: One-piece, free-spinning

type, self-locking bolt. Hex head has six slots in upper surface and circular recess in bottom side adjacent to shank. Elastic flexing of head when tightened against rigid seat develops secure spring locking action.

Design Features: Reusable. Spring action of head greatly increases bolt's overall elastic elongation. Maintains sufficient tension even after considerable embedding of bolt head and settling of joined surfaces. Provides high resistance to loosening by vibration and minimizes fatigue failure, particularly in short bolt lengths. Can be readily adapted to cap screw applications.

Materials: Carbon or alloy steel.

Sizes: ¼ to 1¼-in.; Coarse and Fine threads. Various lengths. Head style is hex.

Source: Produced under license by several manufacturers. Photo, courtesy, National Screw & Mfg. Co. Cleveland.

Plow Bolts

Form: Standard threaded bolts with special flat countersunk heads. Most widely used are No. 3 and No. 7 head types. No. 3 type has square neck; No. 7 type has reverse key on countersunk surface. Square nuts are generally employed for assembly and bolts are mounted in prepared holes to fit flush with part surface.

Design Features: Used primarily in farm equipment and construction machinery. No. 3 bolt can be used in steel parts where holes are either dry-sand or green-sand cored, or punched. It is not well suited for use in thin materials, or close to an edge because of head construction. No. 7 bolt may be used in steel or cast parts and in thinner sections than No. 3.

Materials: Steel.

Sizes: 5/16 to 1 in. nominal diameters; Coarse threads; Class 2A. Body styles include several regular and repair types.

Source: American Standard *Plow Bolts*—ASA B18.9-1950.

Quickey Bolt

Form: Two-piece, all-metal bolt assembly consisting of small bolt

attached to stamped metal tab. Tab snaps into keyhole-shaped cutout in stamped metal parts to hold bolt in place.

Design Features: Provides rapidly installed screw attachment for sheet-metal parts. Can be snapped into place at final assembly simplifying processing and handling of stamped parts.

Materials: Steel.

Sizes: No. 10 to 5/16-in. nominal bolt diameters; Coarse and Fine threads. Grip lengths from 0.04 to 0.134-in. Body styles include several tab shapes.

Source: United-Carr Fastener Corp., Cambridge, Mass.

Rosan Stud

Form: Two-piece, self-locking, tap-end type stud assembly consisting of stud and locking ring. Stud has serrated collar between tap and nut ends, and tap end threads have special pitch to produce slight interference fit with Class 3 tapped threads. Locking ring has serrated ID and OD. Stud is installed in tapped hole and locking ring is pressed into place, engaging inner serrations with collar and driving outer serrations into hole wall to produce a positive lock.

Design Features: Can be installed with standard tools. Locking action resists vibration, temperature variations, and high torque loads. Permits frequent assembly and disassembly.

Materials: Alloy steel.

Sizes: No. 6 to ¾-in. nominal diameters for nut end threads; Coarse and Fine Series; Class 3 A. No. 8 to ⅞-in. nominal diameters for tap end threads; special Coarse thread; Class 3A. Various lengths. Body styles include standard, molded pin, hydraulic, terminal and thru types as well as others.

Source: Rosan Inc., Newport Beach, Calif.

Schweppe Studs

Form: Self-tapping, self-locking, tap-end type stud. Tap-end thread, which has two thread-cutting slots, cuts its own mating thread as stud

is driven into drilled hole. Interference fit produced by thread-cutting action locks stud securely in place.

Design Features: Eliminates the need for separate tapping operation. Locking action resists vibration, stress reversals and temperature change. Can be assembled with standard tools. Adaptable to high-speed assembly methods. Will fit into standard tapped holes.

Materials: Case-hardened alloy steel, high-temperature alloy steel, stainless steel and nonferrous metals.

Sizes: No. 4 to 1 in. nominal diameters; all standard threads. Various lengths.

Source: Pheoll Mfg. Co., Chicago.

Screwstick

Form: One-piece multiple screw assembly for high-production fastening. Screws are joined in "sticks" of 24 to 60 by small necked sections between head and thread ends. They are fed automatically and torqued into position by pneumatic driver. When a screw is fully driven, necked section at head shears off to separate screw from stick.

Design Features: Permits rapid assembly of small screws at rates up to 1500 screws per hour. Driving torque is always applied to head of second screw. Necked section above head of each screw is designed to shear at predetermined torque value, assuring uniform tightening.

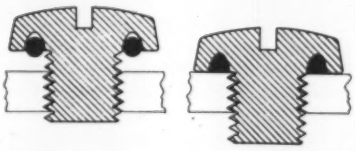
Materials: Brass, aluminum, nickel-silver and steel.

Sizes: No. 0 to No. 6; Coarse and Fine threads. Lengths from 1/16 to 5/16-in. Head style is hex.

Source: American Screw Co., Willimantic, Conn.

Sealskrew

Form: Preassembled screw and



O-ring washer. When screw is tightened, O-ring flows to produce liquid and gas-tight seal under head.

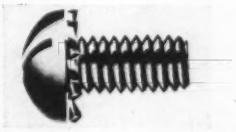
Design Features: Reusable. Provides a rapidly assembled self-sealing fastener. Eliminates separate handling of screw and sealant. Sealing action is effective against external and internal liquid pressures up to 500 psi. Temperature application range is —120 to 500 F. Can be used to seal out dust and combustible vapors.

Material: Screw is stainless steel; O-ring is silicone rubber.

Sizes: No. 4 to ¼-in.; Coarse and Fine threads.

Source: Automatic and Precision Mfg. Co., Yonkers, N. Y.

Sems



Form: Preassembled rolled-thread screw and lock washer. Washer is held securely in position under screw head by expanded diameter of rolled thread.

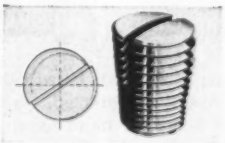
Design Features: Provides high-production locking fastener. Eliminates separate handling of screw and washer. Washer can rotate freely but can't drop off. Shifting of lock washer in tightening is minimized and thread damage due to canting of washer is avoided.

Material: Mild steel.

Sizes: No. 2 to ⅜-in.; Coarse and Fine threads. Screw styles and washer types include a number of different standard combinations.

Source: Shakeproof Div. of Illinois Tool Works, Elgin, Ill.

Setko Offset Set Screw



Form: Slotted, headless, prevailing-torque type self-locking set screw. Slotted sections are offset from true round to produce locking grip on mating threads when set screw is driven into tapped hole.

Design Features: Resists loosening under severe vibration and load conditions. Locking action is not affected by variations in tapped hole threads.

Materials: Cyanide-hardened steel.

Sizes: No. 4 to ¾-in. nominal diameters; Coarse and Fine threads. Lengths from 3/16 to 1 in. Point styles include cup, hanger, flat, half and full dog, cone and pivot.

Source: Set Screw and Mfg. Co., Bartlett, Ill.

Set Screws

Form: Fully threaded screw with special pointed end for engagement with mating surface. It is usually employed in a through tapped hole and tightened to high setting torque value to provide maximum holding power.

Design Features: Used for assembling parts to shafts or to hold parts in relative position to each other. Slotted and socket types provide a flush surface fit. Square head type requires no special wrenches or tools for assembly. Several point styles have been standardized: half dog point is recommended for use in hardened members or where end of thread must be protected; flat point is used with parts requiring frequent adjustment or relocation, or where wall thickness is thin; cone point is used for setting machine parts permanently on shaft; oval point is used against a surface spotted to receive it, or against splined parts; cup point is perhaps most commonly used and is suitable for wide range of general-purpose applications.

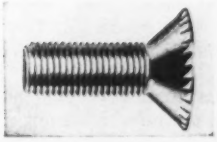
Materials: Heat-treated carbon or alloy steel, stainless steel, brass and other materials.

Sizes: No. 0 to 2 in. nominal diameters; Coarse, Fine and 8-thread series; Class 2A and 3A. Body styles include square head, headless slotted, and hex and fluted socket types. Point styles include cup, flat, oval, cone and full and half dog.

Source: American Standard *Hexagon Head Cap Screws, Slotted Head Cap Screws, Square Head Set Screws, and Slotted Headless Set Screws*—ASA B18.6.2-1956; American Standard *Socket Head Cap Screws and Socket Set Screws*—ASA B18.3-1954.

Spin-Lock Screw

Form: One-piece, all-metal locking screw. Ratchet-like teeth under head imbed in part surface when screw is tightened to provide firm locking grip.



Design Features: Provides a high-production locking fastener. Eliminates separate handling of screw and lock washer. Can be torqued to high tension. Holds tight under extreme vibration or changing temperature conditions. Construction of ratchet teeth permits easy assembly but develops high resistance to loosening. Surface locking action develops fluid-tight seal under head.

Materials: Carburized steel.

Sizes: No. 4 to ½-in.; Coarse and Fine threads. Lengths from minimum of twice screw diameter up.

Source: Russell, Burdsall & Ward Bolt and Nut Co., Port Chester, N. Y.

Stove Bolts

Form: Machine screw with square nut.

Design Features: Used for general-purpose fastening in through holes in light or moderately loaded applications such as electrical equipment, household appliances, toys, etc.

Materials: Steel, brass, aluminum, stainless steel and other materials.

Sizes: ⅛ to ½-in. nominal diameters; Coarse threads; Class 2A. Head styles include round, flat, oval, fillister, truss, pan and hex. Driving recesses include slotted and Phillips.

Source: Produced by several manufacturers. Illustration, courtesy The H. M. Harper Co., Morton Grove, Ill.

Studs

Form: Standard headless, threaded fasteners. Gland or tap-end studs are threaded at one end for semi-permanent, interference fit in a tapped hole and at other end for assembly of standard nut. Length of thread on the nut end may vary but that of the tap end is usually fixed. Double-end studs are threaded at both ends for assembly with two

standard nuts. They are usually symmetrical in design. Continuous thread studs are threaded from end to end.

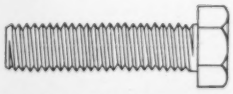
Design Features: Tap-end studs are used where a semipermanent thread attachment is required. They frequently offer advantages in assembly, particularly in high-speed production line operations. Double-end studs are used primarily in flange joints, and similar applications where a double nut adjustment is required.

Materials: Steel, alloy steel, corrosion-resistant steel, brass, aluminum and other materials.

Sizes: ¼ to 1½ in. nominal diameters; Coarse, Fine and 8-thread series; Class of fit varies with stud type and thread function. Lengths from 1 to 6 in.

Source: Industrial Fastener Institute Standard.

Tap Bolts



Form: Regular hexagon headed bolt with pointed end and fully threaded shank. Bolt is usually employed in tapped hole without nut.

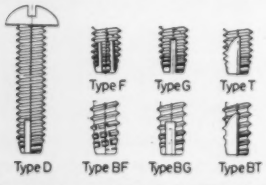
Design Features: Used in applications with a tapped hole where through bolt, stud or cap screw would be impractical.

Materials: Steel.

Sizes: ¼ to 1 in. nominal diameters; Coarse threads; Class 2A. Lengths from ½ to 5 in.

Source: Industrial Fastener Institute Standard.

Thread-Cutting Tapping Screws



Form: Types BF, BG, BT, D, F, G and T American Standard tapping screws. Types BF, BG and BT have spaced threads, blunt point. Types D, F, G and T have machine-screw threads, blunt point. All threads are fully hardened and each screw type has one or more cutting edges and chip cavities located in tapered entering threads. Screws cut close-fitting mating thread when turned into prepared hole.

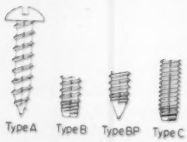
Design Features: Used for application in materials where disruptive internal stresses are not desirable, or where excessive driving torques are encountered with thread-forming screws. Screws remove rather than displace material in forming mating thread. Types BF, BG and BT are used in comparatively thin sections and bosses of friable and brittle plastics, and also in die-castings and other nonmetallic compositions. They require minimum driving torque, resist stripping out, and can be used with thin wall sections because of low side pressures developed. Types D, F, G and T screws are used in sheet metal, structural steel, cast iron, die-castings, brass and bronze forgings and plastics. They provide a close-mating thread fit that resists loosening by vibration or temperature variation.

Materials: Case-hardened steel.

Sizes: No. 0 to ½-in. nominal diameters. Lengths from ⅛ to 1½ in. Head styles include round, flat, oval, fillister, truss, pan, hex and hex washer. Driving recesses include slotted, Phillips and Reed-Prince.

Source: American Standard *Slotted and Recessed Head Tapping Screws and Metallic Drive Screws*—ASA B18.6.4—(Tentative standard awaiting final approval).

Thread-Forming Tapping Screws



Form: Types A, B, BP and C American Standard tapping screws. Type A has spaced thread, gimlet point; Type B has spaced thread, blunt point; Type BP has spaced thread, cone point; and Type C has machine-screw thread, blunt tapered point. Screws form chip-free mating thread when turned into prepared hole. Thread-forming action draws parts together and develops secure locking grip.

Design Features: Used in materials where large internal stresses are permissible or desirable to increase resistance to loosening. Types A and B are the so-called sheet-metal screws. Type A is used to join light-gage sheet metals (0.015 to 0.050-in. thickness) and certain nonmetallic compositions. Type B is heavier duty screw for use in light and heavy sheet metals (0.015 to 0.200-in. thickness), structural sections, nonferrous castings, plastics and other nonmetallic compositions. Type BP is same as Type B but has cone point to facilitate assembly where holes are misaligned. Type C is used in applications where machine-screw tapping thread is desired. It usually requires higher driving torque than spaced-thread types but can be readily assembled to parts with standard internal threads.

Materials: Case-hardened steel.

Sizes: No. 0 to ½-in. nominal diameters. Lengths from 3/16 to 2 in. Head styles include round, flat, oval, fillister, truss, pan, hex and hex washer. Driving recesses include slotted, Phillips and Reed-Prince.

Source: American Standard *Slotted and Recessed Head Tapping Screws and Metallic Drive Screws*—ASA B18.6.4—(Tentative standard awaiting final approval).

Through-Socket Set Screws

Form: Short-body set screw with socket extending completely through body.

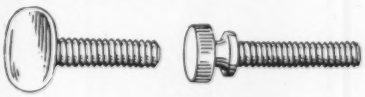
Design Features: Can be used separately as a set screw or with another headless set screw as an internal "locknut" to prevent loosening under severe speed and vibration conditions. Adaptable to high-speed assembly methods.

Materials: Heat-treated alloy steel.

Sizes: No. 4 through 1 in. nominal diameters; Coarse or Fine threads; Class 2A and 3A. Lengths from ⅛ to 1-in. Body styles include hex and fluted sockets.

Source: (Thru-Broached Socket Set Screw) The Bristol Company, Waterbury, Conn.; (Hollow Locking Screw) Strong, Carlisle & Hammond Co., Cleveland. Photo, courtesy The Bristol Co.

Thumb Screws



Form: Standard threaded screw with oversize knurled, spade or "wing" head for hand assembly.

Design Features: Provides a large finger-grip surface to facilitate tightening or removal. Particularly suited for knock-down assembly applications, or where frequent screw adjustments are required.

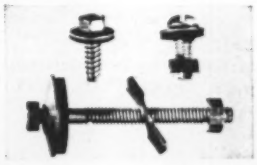
Materials: Steel, brass, aluminum and other materials.

Sizes: No. 4 to ⅜ in. nominal

diameters; Coarse and Fine threads. Various lengths.

Source: Produced by several manufacturers. Illustrations, courtesy The H. M. Harper Co., Morton Grove, Ill.

Topseal Fastener



Form: Preassembled standard screw or bolt and laminated washer of metal and neoprene composition. When fastener is tightened against part surface, bonded neoprene composition extrudes to form watertight seal.

Design Features: Reusable. Neoprene composition seals both at washer edge and screw shank. It is protected from damage in driving by bonded metal backing which provides "free spinning" surface upon which fastener head is free to turn. Adaptable to high-speed assembly methods. Resists vibration. Can be used with corrugated surfaces. Eliminates separate handling of screw and sealant. Forms water-tight seal under 60 lb pressure when tightened to minimum of 25, or maximum of 175, in.-lb torque.

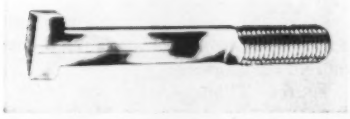
Materials: Screw or bolt is usually steel or standard corrosion-resistant material; bonded metal washer backing is galvanized steel, aluminum, corrosion-resistant steel or vulcanized fibre.

Sizes: All standard screw threads. Washer OD from ⅜ to 3 in. Body styles include all standard bolt and screw types.

Source: Fabricated Products Co., West Newton, Pa.

Tru-Load Bolt

Form: Standard headed and threaded bolt, or capscrew, with unstressed metal reference pin mounted in axial hole in center of shank.



When bolt is unloaded, end of pin is flush with upper surface of bolt head. As bolt is tightened, elongation of shank changes the relative position of the two reference surfaces, providing a direct measure of the actual tensile stress on the bolt shank.

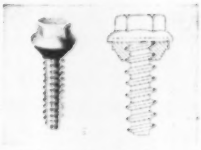
Design Features: Provides accurate measure of actual load on bolt at any time during assembly. Bolt loads can be readily measured using a direct reading stress gage. Used primarily in highly stressed bolt applications where close control of preload is essential assembly requirement.

Materials: All standard materials for threaded fasteners.

Sizes: All standard screw thread sizes.

Source: Precision Threaded Products Div., The Bland Burner Co., Hartford, Conn.

Tuff-Tite Screw



Form: Preassembled screw and molded neoprene washer. Screw, or bolt, is made with special formed undercut washer head. Neoprene washer has tapered cross section which is thicker at ID than at OD.

Design Features: Built-in washer construction reduces possibility of leakage, and offers appearance advantages. Undercut in washer head of screw traps and controls expansion of washer, preventing exposure of neoprene and insuring positive seal when screw is tightened. Sealing action is effective on flat, concave or convex surfaces, and with misaligned holes. Can be used to provide a sealed joint, to protect surface finishes or to reduce noise and vibration in machine assemblies. Application temperature range is −65 to 250 F.

Materials: Screw is corrosion-resistant steel, carbon steel, alloy steel, or nonferrous material, such as aluminum or copper; washer is carbon black filled neoprene.

Sizes: All standard threads. Screw types include tapping and drive, machine and others.

Source: Townsend Co., New Brighton, Pa.

Weld Screws

Form: Flat-top round-head screw having welding projections on bottom or top side. Screw is projection welded in place on part surface.

Design Features: Provides a permanent fixed screw attachment for metal parts. Adaptable to high-speed assembly methods. Type with projections under head is mounted in prepared hole and is used to provide a self-locating through bolt where a flush surface is required for attachment of mating parts. Type shown, with projections on top of head, eliminates need for drilling or punching of mounting holes and is used where a smooth outside surface is required for appearance purposes.

Materials: Low-carbon steel or stainless steel.

Sizes: No. 6 to ½-in. nominal diameter; Coarse and Fine threads. Lengths from ¼ to 2½ in. Head styles include projections, spherical, rib, annular ring, button and others.

Source: Ohio Nut & Bolt Co., Berea, Ohio.

WASHERS

Simple but important elements of fastener hardware, washers can serve several different purposes. Primary functions are as a bearing surface, a spring-takeup device or a locking element. They can also be used to improve appearance, to provide sealing or to prevent damage to finished surfaces.

Washers discussed in this section are typical of basic types designed specifically for use in fastener assemblies. In addition to these, a wide range of special-purpose and custom made types are available from different manufacturers.

Duo-Seal Washer

Form: One-piece washer and O-ring assembly, permanently bonded

together. Used under bolt head to develop positive seal in mechanical joint assemblies.

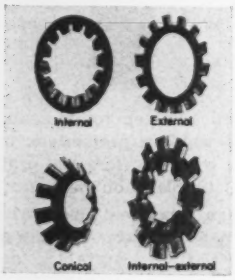
Design Features: Washer provides correct amount of squeeze on O-ring to assure effective sealing. Eliminates need for special O-ring recess. Provides leakproof seal against fluids, gases or air around bolts passing through walls, or bulkheads in equipment or structural assemblies.

Materials: Washer is steel, chrome-moly steel or brass; O-ring is silicone or other rubber formulations.

Sizes: No. 4 to 2 in. nominal ID.

Source: Rubber Teck, Inc., Gardena, Calif.

Everlock Lock Washers



Form: Type B American Standard tooth lock washers. Under pressure of application, multiple heat-treated teeth on outer or inner, or both, diameters of washer bite into fastener and working member to provide locking action.

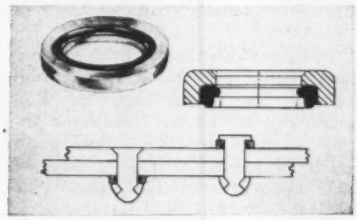
Design Features: Each tooth is formed to provide two chisel edges, projecting on opposite faces. Sufficient spring action exists in tooth construction to accommodate fastener expansion and contraction under severe temperature changes. Several types have been standardized. Internal type is used under small head screws (fillister, etc.) or where it is desirable to hide teeth for appearance or to prevent snagging. Heavy internal type is used with heavy bolts and nuts, and with heat-treated bolts, usually on castings and heavy machinery or equipment. External type is used with fasteners having heads large enough to contact the lock washer teeth (round, pan, binding head, etc.). Conical external type is used with flat or oval-head countersunk screws. Internal-external type is used where large bearing surface is required, for oversize or elongated holes, and as an insert between adjustable members to maintain adjustment settings.

Materials: Hardened and tempered medium-carbon steel.

Sizes: No. 2 to 1¼ in. nominal screw sizes. Size range varies for individual types.

Source: Thompson-Bremer & Co., subsidiary of American Machine & Foundry Co., Chicago. Basic washer details given in American Standard *Lock Washers*—ASA B27.1-1950.

Gask-O-Seal



Form: One-piece washer unit consisting of cup-shaped metal retainer into which rubber seal is bonded. Projecting portions of rubber seal are pressed flat when fastened, providing contact with all internal surfaces.

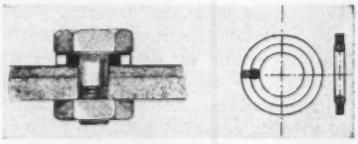
Design Features: Dimensions of metal member are such that rubber sealing element is completely confined; no cold flow is developed. Positive contact of seal on all four sides produces effective sealing action at high and low pressures. Metal-to-metal contact of parts is maintained for high strength. Simple design of seal eliminates need for close tolerances. Washer is reusable. Used primarily to seal rivets and bolts in joints with close-fitting holes.

Materials: Metal retainer is chrome-moly steel; seal is silicone rubber or black nitrile rubber in one of several compositions.

Sizes: $\frac{1}{8}$ to $\frac{1}{8}$-in. nominal ID.

Source: Franklin C. Wolfe Co. Inc., Culver City, Calif.

Lock-O-Seal



Form: Two-piece washer assembly consisting of synthetic rubber O-ring mounted inside metal support ring.

Design Features: Dimensions of support ring are such that rubber sealing element is completely confined; no cold flow is developed. Positive contact of seal on four sides produces effective sealing action at high and low pressures. Metal-to-metal contact of parts is maintained for high strength. Simple construction of seal eliminates need for close tolerances. Washer is reusable. Not recommended for use with coarse or large threads. Used for liquid and gas sealing of bolted and riveted joints.

Materials: Support ring is steel, aluminum, stainless steel, or chrome-moly steel; O-ring is Kel-F plastic, white or red silicone rubber, or one of several compositions of black nitrile rubber.

Sizes: No. 2 to 2 in. nominal ID.

Source: Franklin C. Wolfe Co. Inc., Culver City, Calif.

Plain Washers

Form: Standard flat disk washers with center opening to fit under nut or head of bolt or screw.

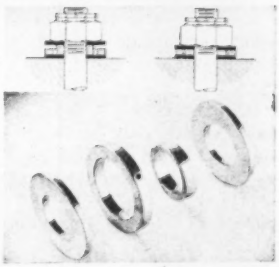
Design Features: Used to insulate exposed nut or bolt head from the part, to improve appearance, to protect part surface from damage, or to distribute load over wider area of the contact surface.

Materials: All standard engineering materials.

Sizes: $\frac{5}{64}$ to 3⅛ in. ID; $\frac{1}{8}$ to 5½ in. OD. Thicknesses from No. 25 to No. 2 gage.

Source: American Standard *Plain Washers*—ASA B27.2-1953.

Preload Indicating Washer



Form: Four-piece washer assembly consisting of two concentric steel rings sandwiched between two close-tolerance, hardened steel washers. Inner ring is thicker than outer ring by predetermined amount. Tightening of bolt compresses inner ring. When outer ring can no longer be moved freely by pin inserted in peripheral hole, known preload in bolt is indicated.

Design Features: Indicates an average preload of 80 per cent of minimum bolt yield strength. Accuracy is within 10 per cent. Presence of sealant, oil, grease, and dirt has little or no affect on indicating accuracy. Designed for use with bolts of 80,000 to 200,000 psi minimum ultimate strength where high

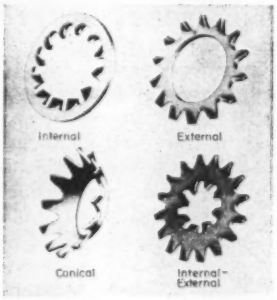
controlled preload is required.

Materials: Alloy steel.

Sizes: No. 10 to 1½ in. nominal ID; for bolts with 125,000 to 160,000 psi minimum ultimate strength.

Source: Standard Pressed Steel Co., Jenkintown, Pa.

Shakeproof Lock Washers



Form: Type A American Standard tooth lock washers. Under pressure of application, multiple heat-treated teeth on outer or inner, or both, diameters of washer bite into fastener and working member to provide locking action.

Design Features: Each tooth is tapered and twisted, providing spring reaction under tightening loads that resists flattening forces and loosening effect of vibration. Cushioning action also acts to protect against damage from overdriving of fastener members in assembly. Several types have been standardized. Internal type is used under small head screws (fillister, etc.) or where it is desirable to hide teeth for appearance or to prevent snagging. Heavy internal type is used with heavy bolts and nuts, and with heat-treated bolts, usually on castings and heavy machinery or equipment. External type is used with fasteners having heads large enough to contact the lock washer teeth (round, pan, binding head, etc.). Conical external type is used with flat or oval head countersunk screws. Internal-external type is used where large bearing surface is required, for oversize or elongated holes, and as an insert between adjustable members to maintain adjustment settings.

Materials: Hardened and tempered medium-carbon steel.

Sizes: No. 2 to 1¼ in. nominal screw sizes. Size range varies for individual types.

Source: Shakeproof Div. of Illinois Tool Works, Elgin, Ill. Basic washer details given in American Standard *Lock Washers*—ASA B27.1-1950.

Spring Lock Washers

Form: Helically coiled hardened wire washer. It usually has slightly trapezoidal section, thicker at ID than OD. Washers are coiled so that the free height is approximately twice the thickness of the washer section.

Design Features: Functions as spring takeup device to compensate for developed looseness and loss of tension between component parts of an assembly, and as a hardened thrust bearing to facilitate assembly and disassembly of bolted fastenings by decreasing the frictional resistance between the bolted surface and the bearing face of the bolt head or nut.

Materials: Carbon steel, corrosion-resistant steel, aluminum-zinc alloy, phosphor-bronze, silicon-bronze or K-Monel.

Sizes: No. 2 to 1½ in. nominal ID. Washer styles include light, medium, heavy and extra heavy types as well as different coil shapes.

Source: The Spring Washer Institute, New York. Basic washer details are covered in American Standard *Lock Washers*—ASA B27.1-1950.

Stat-O-Seal

Form: Two-piece washer unit consisting of toroidal synthetic-rubber sealant molded over inward projecting fingers of metal retainer ring.

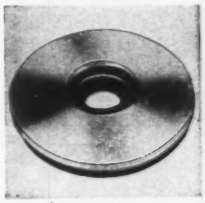
Design Features: Dimensions of retainer ring are such that rubber sealing element is completely confined; no cold flow is developed. Positive contact of seal on four sides produces effective sealing action at high and low pressures. Metal-to-metal contact of parts is maintained for high strength. Simple washer construction eliminates need for close tolerances. Washer is reusable. Used for liquid and gas sealing of bolts and studs.

Materials: Retainer ring is steel, aluminum and chrome-moly steel; seal is white or red silicone rubber or one of several compositions of black nitrile rubber.

Sizes: No. 6 to 1⅞ in. nominal ID.

Source: Franklin C. Wolfe Co Inc., Culver City, Calif.

Weath-R-Seal Washer



Form: Laminated compression washer consisting of metal backing layer bonded to resilient neoprene composition washer. When compressed by tightening of fastener, neoprene composition produces seal around outside diameter of metal backing and fastener shank.

Design Features: Cushioning action of seal is useful in reducing vibration and in protecting surface finish of parts. Washer forms watertight seal under 60 lb pressure when tightened against contact surface at recommended torque values. Shaped metal backing controls flow of neoprene composition under compression and protects it from damage as fastener is being driven. Even distribution of neoprene composition assures positive long-life sealing effectiveness.

Materials: Metal backing is steel, aluminum, or corrosion-resistant steel.

Sizes: Standard bolt and screw sizes. OD from ⅜ to 3 in.

Source: Fabricated Products Co., West Newton, Pa.

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One-Piece Housing Lightens Grinder

A ONE-PIECE light-alloy housing, careful redesign to keep the number of parts used to a minimum, and careful sizing and proportioning of air passages has resulted in a recently announced air tool said to develop 50 per cent more power than much heavier similar tools with only 1/6 as much noise. Made by Thor Power Tool Co., this new 5V model may be used for cup and disk grinding, disk sanding and wire brushing. Weight of the tool is 7 5/16 lb; height is 6 1/16 in., and operating speeds are 4500, 6000 or 8000 rpm.

Simplified design is shown by a comparison of the parts of the new model with those of the design it replaces. Although considerable simplification has been achieved throughout, most marked reduction in number of parts is achieved by use of the one-piece housing and elimination of the through-bolts used with the multiple-piece housing. Housing and the two handles of the new design are aluminum castings. These account for most of the weight reduction.

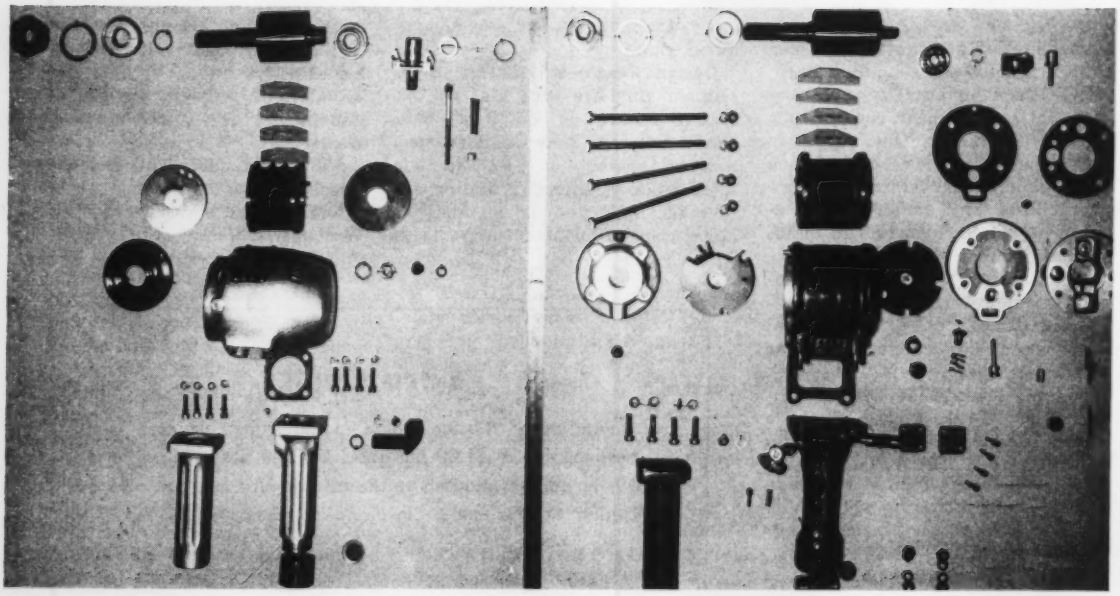

Fig. 1—Miniature screws in relation to type size of commercial typewriter. On these special watch screws, major thread diameters range from 0.30 to 0.90 mm (0.118 to 0.0354-in.).

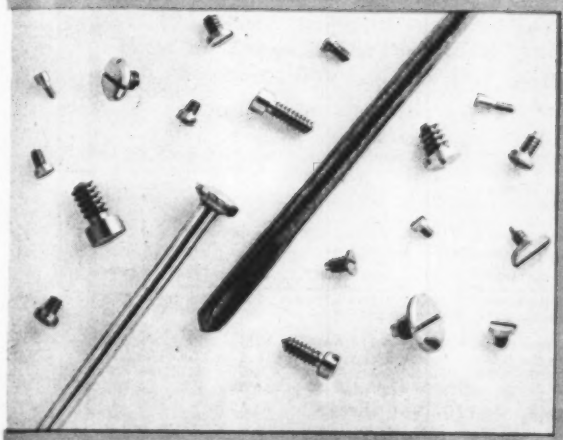

Fig. 2—Stainless-steel miniature screws compared with a pin and a sewing needle.

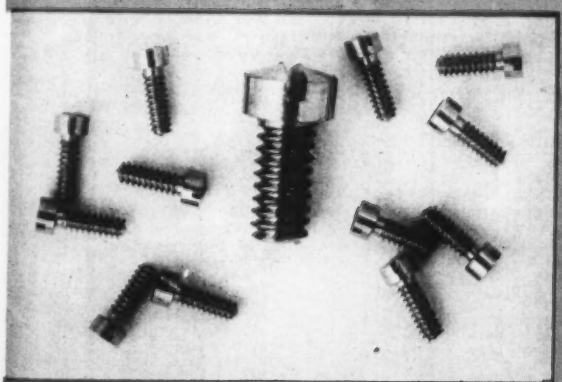

Fig. 3—No. 0-80 machine screw compared with miniature fillister-head screws of 0.60-mm (0.0236-in.) major thread diameter.

MINIATURE SCREWS

. . . a report on two new standards for threads and fasteners

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STANDARDIZED screw threads seem no novelty since their interchangeability in most products has been common for many years. This happy state has been true, though, in a size range above the No. 0-80 (0.060-in.) machine-screw thread—not for anything smaller.

At one time, lack of interchangeability and apparent confusion below 0.060-in. diameter mattered little. Although the problems were many, they were so tiny and bothered so few people. Miniature screws were used principally in watches. The watch companies, each with its line of proprietary products, went their own ways, with neither compulsion nor reason influencing any attempts toward standardization.

But just as World War I emphasized the need for improved standardization of the larger thread sizes, World War II, through the impetus it gave to instrumentation and miniaturization, pointed up the rapidly increasing importance of the smaller screw threads and the dire need for their standardization.

In the United States, standardization of miniature threads has been under continuous study since 1944. Collaboration with the other principal inch-using countries of the world under the ABC program, and with the metric countries through the International Organization for Standardization (ISO), has now brought to fruition a miniature thread standard that will be common to all the industrial countries of the world.

A natural sequel to the development of the thread standard is the activity, also nearing com-

*Also, chairman, subcommittee on instrument screw threads, ASME-B1.4.

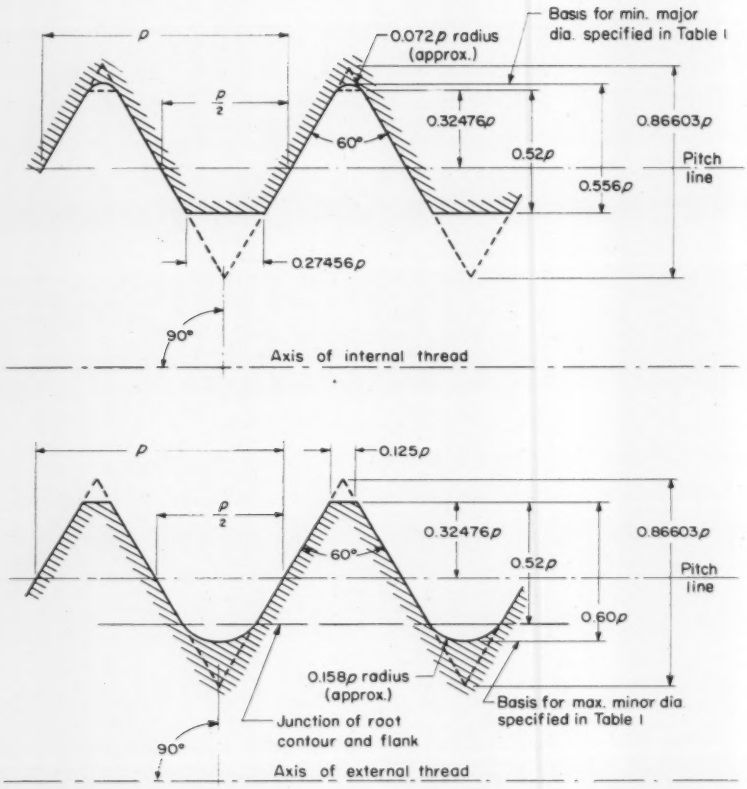


Fig. 4—Design (maximum-material) thread forms of Miniature Screw Threads.

pletion, on a standard for miniature fastening screws.

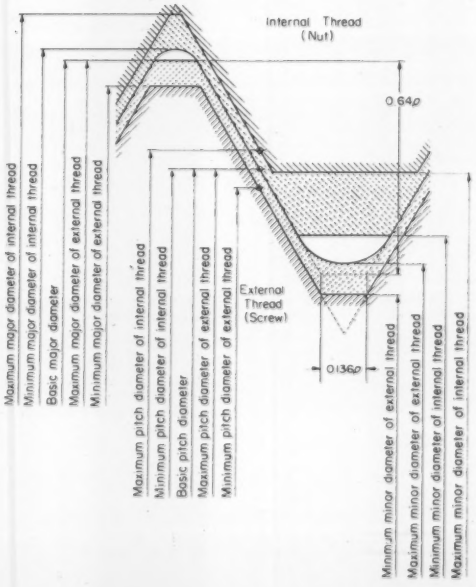
Some appreciation of the threads and fasteners with which these two standards are concerned can be derived from Figs. 1-3.

The highlights of these two standards are presented in this article. Since both standards will soon be circulated for industry comment, this discussion may aid interpretation of the standards and possibly stimulate questions or suggestions. Such comment will be welcomed by the several ASA committees involved and may prove helpful before final approval of the standards.

Miniature Screw Threads

The proposed standard, to be known as Miniature Screw Threads, is intended for general-purpose fastening screws in watches, instruments, and miniature mechanisms. The series covers a diameter range from 0.30 to 1.40 mm (0.0118 to 0.0551-in.) and thus supplements the Unified and American thread series which begins at 0.060-inch. It is comprised of a total of 14 sizes which, together with their respective pitches, are those endorsed by the American-British-Canadian Confer-

Fig. 5—Limits of size for 120 NM thread.


Internal Thread (Nut)
0.64p
External Thread (Screw)
0.136p
Maximum major diameter of internal thread
Minimum major diameter of internal thread
Basic major diameter
Maximum major diameter of external thread
Minimum major diameter of external thread
Maximum pitch diameter of internal thread
Minimum pitch diameter of internal thread
Basic pitch diameter
Maximum pitch diameter of external thread
Minimum pitch diameter of external thread
Minimum minor diameter of external thread
Maximum minor diameter of external thread
Minimum minor diameter of internal thread
Maximum minor diameter of internal thread

ence as the basis for a unified standard among the inch-using countries, and coincide with the corresponding range of sizes recommended by ISO.

Additionally, it utilizes thread forms which are compatible in all significant respects with both the Unified and ISO basic thread profiles. Thus, this thread series establishes interchangeability with the corresponding sizes in both the ABC and the ISO standardization programs.

The 14 sizes are systematically distributed, providing a uniformly proportioned selection over the entire range. They are alternately separated into two categories. The sizes shown in bold-face type in accompanying tables are selections made in the interest of simplification and are those to which it is recommended that usage be confined wherever the circumstances of design permit. For more restrictive conditions the intermediate sizes shown in light-face type are available.

The diameter-pitch combinations have been determined to provide both maximum strength against stripping and optimum conditions for manufacture on an interchangeable basis.

Form of Thread: The theoretical profile on which the design forms of the threads covered by the standard are based is, except for one element, the Unified and American basic thread form as presented in American Standard Unified and American Screw Threads—ASA B1.1-1949. An exception is thread height, for which a basic value of $0.52p$ is used instead of $0.54127p$ ($5\ H/8$). Selection of this value is based on the simplification which it affords throughout the calculations for the miniature-thread standard. This modification will not affect interchangeability with product made to any other standards retaining $0.54127p$, since the resulting difference is negligible and completely offset by practical considerations in tapping.

The design forms (maximum material condition) of the external and internal theads are shown in Fig. 4.

Nominal Sizes: The thread sizes comprising the miniature series and their respective pitches are shown in the left-hand columns of Table 1. Only one class of thread is established with zero allowance on all diameters.

Tolerances: In Table 1 tolerances are shown for

Table 1—Limits of Size and Tolerances

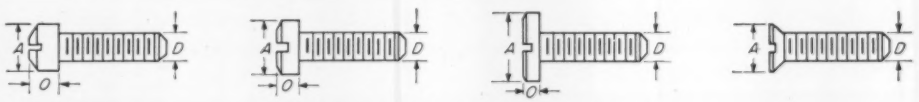
Size Desig- nation	Pitch (mm)	Threads per Inch	External Threads: Major Diam. Max.	Major Diam. Min.	Major Diam. Tol.	Pitch Diameter Max.	Pitch Diameter Min.	Pitch Diameter Tol.	Minor Diam. Max.	Minor Diam. Min.	Internal Threads: Minor Diam. Min.	Minor Diam. Max.	Minor Diam. Tol.	Pitch Diam. Min.	Pitch Diam. Max.	Pitch Diam. Tol.	Major Diam. Min.	Major Diam. Max.
30 NM	**0.080**	**318**	**0.0118**	**0.0112**	**0.0006**	**0.0098**	**0.0092**	**0.0006**	**0.0080**	**0.0072**	**0.0085**	**0.0100**	**0.0015**	**0.0098**	**0.0104**	**0.0006**	**0.0120**	**0.0129**
35 NM	.090	282	.0138	.0131	.0007	.0115	.0109	.0006	.0095	.0087	.0101	.0117	.0016	.0115	.0121	.0006	.0140	.0149
40 NM	**.100**	**254**	**.0157**	**.0150**	**.0007**	**.0132**	**.0126**	**.0006**	**.0110**	**.0101**	**.0117**	**.0134**	**.0017**	**.0132**	**.0138**	**.0006**	**.0160**	**.0170**
45 NM	.100	254	.0177	.0170	.0007	.0152	.0145	.0007	.0130	.0120	.0136	.0154	.0018	.0152	.0158	.0006	.0180	.0190
50 NM	**.125**	**203**	**.0197**	**.0189**	**.0008**	**.0165**	**.0158**	**.0007**	**.0138**	**.0127**	**.0146**	**.0166**	**.0020**	**.0165**	**.0172**	**.0007**	**.0200**	**.0212**
55 NM	.125	203	.0217	.0208	.0009	.0185	.0178	.0007	.0157	.0146	.0165	.0186	.0021	.0185	.0192	.0007	.0220	.0231
60 NM	**.150**	**169**	**.0236**	**.0227**	**.0009**	**.0198**	**.0190**	**.0008**	**.0165**	**.0153**	**.0173**	**.0198**	**.0023**	**.0198**	**.0206**	**.0008**	**.0240**	**.0254**
70 NM	.175	145	.0276	.0265	.0011	.0231	.0222	.0009	.0193	.0179	.0204	.0231	.0027	.0231	.0239	.0008	.0281	.0298
80 NM	**.200**	**127**	**.0315**	**.0303**	**.0012**	**.0264**	**.0254**	**.0010**	**.0220**	**.0205**	**.0233**	**.0263**	**.0030**	**.0264**	**.0273**	**.0009**	**.0321**	**.0337**
90 NM	.225	113	.0354	.0341	.0013	.0297	.0287	.0010	.0248	.0231	.0262	.0295	.0033	.0297	.0307	.0010	.0361	.0379
100 NM	**.250**	**102**	**.0394**	**.0380**	**.0014**	**.0330**	**.0319**	**.0011**	**.0276**	**.0257**	**.0291**	**.0327**	**.0036**	**.0330**	**.0341**	**.0011**	**.0401**	**.0420**
110 NM	.250	102	.0433	.0419	.0014	.0369	.0358	.0011	.0315	.0296	.0331	.0367	.0036	.0369	.0380	.0011	.0440	.0458
120 NM	**.250**	**102**	**.0472**	**.0458**	**.0014**	**.0409**	**.0398**	**.0011**	**.0354**	**.0335**	**.0370**	**.0406**	**.0036**	**.0409**	**.0420**	**.0011**	**.0480**	**.0499**
140 NM	.300	85	.0551	.0535	.0016	.0474	.0462	.0012	.0409	.0387	.0428	.0471	.0043	.0474	.0487	.0013	.0560	.0583

All dimensions, except pitch, are inches.
Sizes shown in bold-face type are preferred. It is recommended that selections be confined to these sizes insofar as possible.

Table 2—Hole-Size Limits Before Tapping

Desig- nation	Pitch (mm)	Threads per Inch	Minor Diameter Limits (in.) Min.	Minor Diameter Limits (in.) Max.	Percentage of Basic Thread Height Max.	Percentage of Basic Thread Height Min.	Suggested Hole Size (in.) Vs. Length of Engagement: To and Including 2/3 D Min.	To and Including 2/3 D Max.	Above 2/3 D to 1½ D Min.	Above 2/3 D to 1½ D Max.	Above 1½ D to 3 D Min.	Above 1½ D to 3 D Max.
30 NM	**0.080**	**318**	**0.0085**	**0.0100**	**100**	**54.8**	**0.0089**	**0.0095**	**0.0093**	**0.0100**	**0.0098**	**0.0104**
35 NM	.090	282	.0101	.0117	100	56.4	.0105	.0111	.0109	.0117	.0113	.0121
40 NM	**.100**	**254**	**.0117**	**.0134**	**100**	**57.7**	**.0121**	**.0127**	**.0125**	**.0134**	**.0130**	**.0138**
45 NM	.100	254	.0136	.0154	100	57.7	.0141	.0147	.0145	.0154	.0149	.0158
50 NM	**.125**	**203**	**.0146**	**.0166**	**100**	**60.0**	**.0150**	**.0158**	**.0156**	**.0166**	**.0161**	**.0171**
55 NM	.125	203	.0165	.0186	100	60.0	.0170	.0178	.0176	.0186	.0181	.0191
60 NM	**.150**	**169**	**.0173**	**.0198**	**100**	**61.5**	**.0181**	**.0190**	**.0187**	**.0198**	**.0193**	**.0204**
70 NM	.175	145	.0204	.0231	100	62.6	.0211	.0221	.0217	.0231	.0224	.0237
80 NM	**.200**	**127**	**.0233**	**.0263**	**100**	**63.5**	**.0240**	**.0252**	**.0248**	**.0263**	**.0256**	**.0270**
90 NM	.225	113	.0262	.0295	100	64.1	.0270	.0283	.0279	.0295	.0287	.0304
100 NM	**.250**	**102**	**.0291**	**.0327**	**100**	**64.6**	**.0300**	**.0314**	**.0309**	**.0327**	**.0319**	**.0337**
110 NM	.250	102	.0331	.0367	100	64.6	.0340	.0354	.0349	.0367	.0358	.0376
120 NM	**.250**	**102**	**.0370**	**.0406**	**100**	**64.6**	**.0379**	**.0393**	**.0388**	**.0406**	**.0397**	**.0415**
140 NM	.300	85	.0428	.0471	100	65.4	.0439	.0455	.0450	.0471	.0460	.0481

Table 3—Head Details of Miniature Screws



Size Designation	Basic Maj. Diam. of Thd.	Fillister Head: Head Diam., A Max.	Fillister Head: Head Diam., A Min.	Fillister Head: Head Height, O Max.	Fillister Head: Head Height, O Min.	Pan Head: Head Diam., A Max.	Pan Head: Head Diam., A Min.	Pan Head: Head Height, O Max.	Pan Head: Head Height, O Min.	Binding Head: Head Diam., A Max.	Binding Head: Head Diam., A Min.	Binding Head: Head Height, O Max.	Binding Head: Head Height, O Min.	Flat Head: Head Diam., A Max.	Flat Head: Head Diam., A Min.
30 NM	**0.0118**	**0.021**	**0.019**	**0.012**	**0.010**	**0.025**	**0.023**	**0.010**	**0.008**	**0.033**	**0.031**	**0.008**	**0.006**	**0.023**	**0.021**
35 NM	.0138	.023	.021	.014	.012	.029	.027	.011	.009	.037	.035	.009	.007	.025	.023
40 NM	**.0157**	**.025**	**.023**	**.016**	**.013**	**.033**	**.031**	**.012**	**.009**	**.041**	**.039**	**.010**	**.007**	**.029**	**.027**
45 NM	.0177	.029	.027	.018	.015	.037	.035	.014	.011	.045	.043	.011	.008	.033	.031
50 NM	**.0197**	**.033**	**.031**	**.020**	**.017**	**.041**	**.039**	**.016**	**.013**	**.051**	**.049**	**.012**	**.009**	**.037**	**.035**
55 NM	.0217	.037	.035	.022	.019	.045	.043	.018	.015	.057	.053	.014	.011	.041	.039
60 NM	**.0236**	**.041**	**.039**	**.025**	**.021**	**.051**	**.049**	**.020**	**.016**	**.062**	**.058**	**.016**	**.012**	**.045**	**.043**
70 NM	.0276	.045	.043	.028	.024	.057	.053	.022	.018	.072	.068	.018	.014	.051	.049
80 NM	**.0315**	**.051**	**.049**	**.032**	**.028**	**.062**	**.058**	**.025**	**.021**	**.082**	**.078**	**.020**	**.016**	**.057**	**.053**
90 NM	.0354	.057	.053	.036	.032	.072	.068	.028	.024	.092	.088	.022	.018	.062	.058
100 NM	**.0394**	**.062**	**.058**	**.040**	**.035**	**.082**	**.078**	**.032**	**.027**	**.102**	**.098**	**.025**	**.020**	**.072**	**.068**
110 NM	.0433	.072	.068	.045	.040	.092	.088	.036	.031	.115	.105	.028	.023	.082	.078
120 NM	**.0472**	**.082**	**.078**	**.050**	**.045**	**.102**	**.098**	**.040**	**.035**	**.125**	**.115**	**.032**	**.027**	**.092**	**.088**
140 NM	.0551	.092	.088	.055	.050	.115	.105	.045	.040	.145	.135	.036	.031	.102	.098

All dimensions are inches.

all miniature sizes; Fig. 5 shows the effect of tolerances at large scale for one of the standard sizes. Tolerances governing limits of size are based on functions of the pitch only and apply to lengths of engagement from 2/3 to 1½ times the nominal diameter.

Coated Threads: It is not within the scope of the standard to make recommendations for thicknesses of, or to specify limits for, coatings. However, it is obvious that in these small sizes any coatings applied must be kept thin because of the smallness of the threads. Generally, the coatings employed in practice are confined to those of the electroplated or oxide types and are limited to a flash thickness. For applications where these coatings are inadequate, the product is usually made of a corrosion-resistant material, thereby avoiding the problems attendant to providing for heavier coatings. However, where coatings of a measurable thickness are required, it is essential that they be included within the maximum material limits since no allowance is provided between these limits of the external and internal thread. In other words, the maximum material limits given in the standard apply to both uncoated and coated threads.

Designation: It is recommended that miniature screw threads be designated on engineering drawings, in specifications, and on tools and gages (when space permits) by their nominal diameters in hundredths of a millimeter followed by the sym-

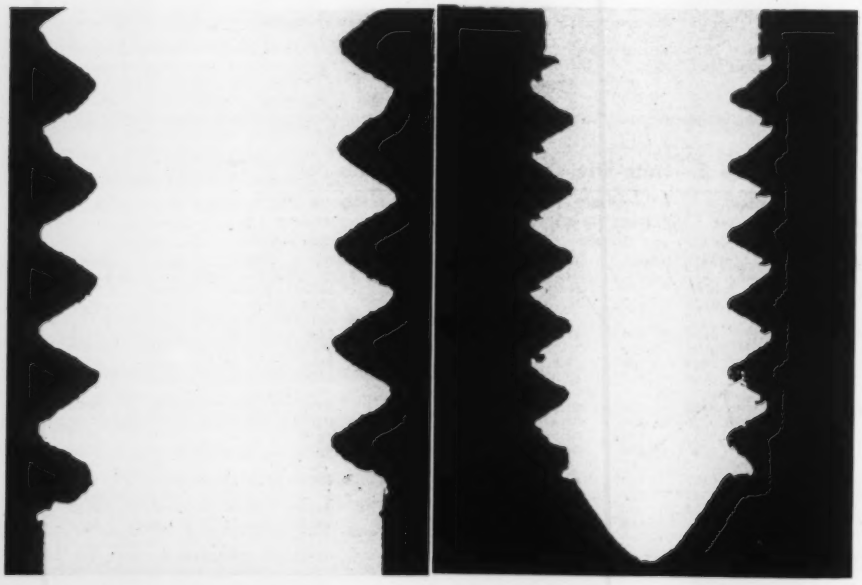


Fig. 6—Sections of miniature screw threads: (extreme left) die-cut, stainless steel, 339 threads per inch; (left) spun thread, 282 threads per inch.

Table 4—Screw-Body Lengths

Nominal and Max.	Min.
0.012	0.009
.016	.013
.020	.016
.025	.021
.032	.027
.040	.035
.050	.044
.060	.054
.080	.072
.100	.092
0.120	0.110
.160	.150
.200	.188
.250	.238
.320	.304
.400	.384
.500	.480
.600	.580

Minimum standard length of screw (*L*) for each size shall be the nominal length just above

1. One times the nominal thread diameter for screws having a flat bearing-surface type of head.
2. One and one-half times the nominal thread diameter for screws having a conical bearing-surface type of head.

Maximum standard length for each size, regardless of head type, shall be the nominal length just above ten times the nominal thread diameter.

Threaded length shall extend to within two threads of the bearing surface of the head, or closer if practicable, on all screws having a length *L*, four times the nominal diameter or less. Screws of greater length shall possess complete threads for a minimum of four diameters. On screws not threaded to the head the diameter of the unthreaded body shall not be less than the minimum pitch diameter of the thread nor more than the maximum major diameter of the thread.

All dimensions are inches.

bol "NM." To these designations may be affixed, in parentheses, the inch equivalent of the basic major diameter, but this addition is optional. Thus, for example, the thread size identified by the designation 80 NM may also be designated 80 NM (0.0315).

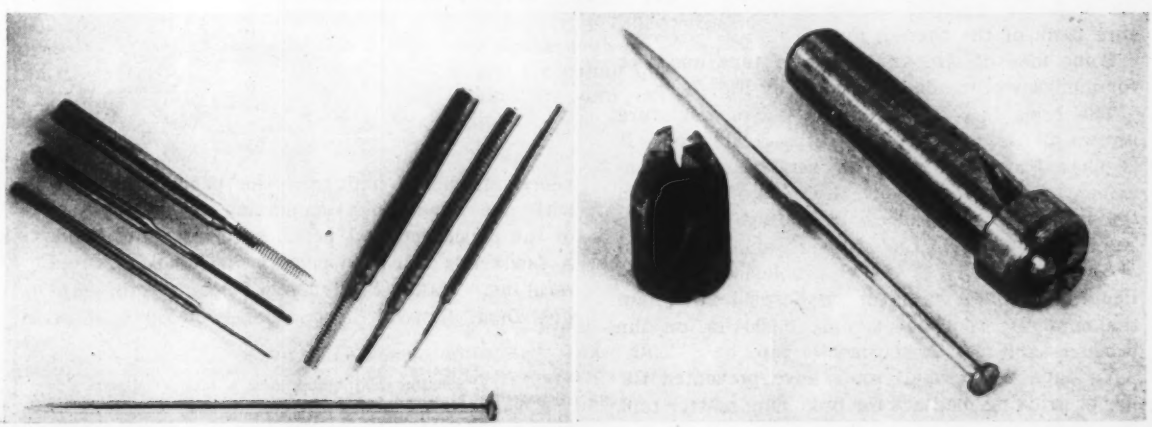
Acceptability: The formulation of recommended methods for determining acceptability of these threads is anticipated after the accumulation of further experience with the thread standard. Until such time, agreements must be reached between purchaser and vendor regarding the basis for determining acceptance, since practices are various and differ considerably, particularly for external threads. Where a free choice is possible, the following procedures, which are being successfully used by some producers, are suggested. For external threads, the utilization of optical projection instead of ring gaging overcomes many of the uncertainties stemming from the difficulties of establishing the accuracy of, and duplicating, thread ring gages in these small sizes.

The major diameter of the external thread is inspected by either contact gaging or optical projection. All other dimensions, such as pitch diameter, lead, thread form and minor diameter, are inspected by optical projection methods with a magnification of 100X recommended.

The minor diameter of the internal thread is gaged with "GO" and "NOT GO" plain cylindrical plug gages. All other elements are checked only for assembleability limits by means of a "GO" thread plug gage. For the minimum material limit of the internal thread, accuracy and performance of the tap are relied upon. This implies that the major and pitch diameters of the tap do not exceed the maximum internal thread limits for these elements and disregards overcutting, which is rarely incurred because of the flexibility of these small taps and the manner in which they are generally fluted.

Hole Sizes for Tapping: Table 2 lists the hole-size limits recommended for tapping. These limits are derived from the internal thread minor diameter limits given in Table 1 and are disposed so as to provide the optimum conditions for tapping. The maximum limits are based on providing a functionally adequate fastening for the most common applications, where the material of the externally threaded member is of a strength essentially equal to or greater than that of its mating part. In applications where, because of considerations other than the fastening, the screw is made of an appreciably weaker material, the use of smaller hole sizes is usually necessary to extend thread engagement to a greater depth on the external thread. However, hole sizes down to the minimum

Fig. 7—Working taps (left) ranging from 30 to 90 NM, and fluted dies for cutting miniature threads.



limit of the minor diameters must be avoided to allow for the spin-up developed as the result of the negative rake with which these small taps are usually ground.

Miniature Fastening Screws

Details of the proposed new standard on screws are presented in abbreviated form in Tables 3-5. All head diameters given in Table 3 have been selected from the head-diameter series of Table 5. It is suggested that the series in Table 5 should also govern the design of any special screws.

Production Methods: Miniature screws are invariably formed by machining rather than by cold-upsetting methods. Rod stock is fed through guide-bushing type automatic machines which can deliver finished screws at the rate of one every 5 seconds.

Method of threading varies to some extent. For highest quality threads and where tough materials are encountered, adjustable cutting dies are employed. Fig. 6 shows a cross-section of a miniature thread die-cut of stainless steel.

Where a lower quality is permissible and the material is sufficiently ductile, the threads are spun up with forcing plates which are simply hardened nuts. Although this method is similar to thread rolling, the thread differs. The fold produced by the displaced material usually occurs on the pressure flank of the thread, Fig. 6.

Some idea of size and detail of taps and dies for miniature threads is provided by Fig. 7.

The basic tool in the production of miniature screws and tapped products is the master tap. It is chased on high-precision semiautomatic machines. Besides an abnormally severe problem in the holding of tolerances, difficulties arise from deformations due to tool pressure and breakdown of the tool point. The latter problem can be particularly troublesome in the smallest pitches where the minimum root flat is only 0.0004-in. on the product—and less on the master tap.

To date, these small roots have prevented the use of grinding methods for producing master taps and thread plug gages. The machining methods have proved successful only with careful selection of tool steels and special bright-hardening techniques to preserve the machined accuracy.

Production of miniature threaded products obviously is dependent upon high-precision delicate gages, measuring machines, and projectors. The order of accuracy required is suggested by this one detail: For pitch diameter measurement of the smallest thread plug gages, wires only 0.0022-in. diameter (human hair, 0.003 or 0.004-in.) are required.

Table 5—Head-Diameter Series

Nominal	Max.	Min.	Nominal	Max.	Min.
0.020	0.021	0.019	0.060	0.062	0.058
.022	.023	.021	.070	.072	.068
.024	.025	.023	.080	.082	.078
.028	.029	.027	.090	.092	.088
.032	.033	.031	.100	.102	.098
.036	.037	.035	.110	.115	.105
.040	.041	.039	.120	.125	.115
.044	.045	.043	.140	.145	.135
.050	.051	.049	.160	.165	.155
.055	.057	.053	.180	.185	.175

All dimensions are inches.

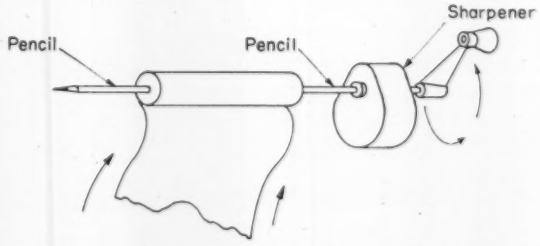
Comments? Questions?

Standards serve their intended purposes only if needed—and used without undue reservation. Do you have comments—pro or con—or questions on these thread and screw standards? They will be welcomed by the ASA subcommittees, and may be addressed to Editor, *Machine Design*, Penton Bldg., Cleveland 13, O., for forwarding.

Tips and Techniques

Rolling Tracings

A pencil sharpener can greatly facilitate rolling long tracings or oscillograms when no automatic equipment is available. First tape a pencil to the end of the tracing at each edge as shown. Then manually roll the tracing around the pencils a few times. Next insert one of the pencils into the



pencil sharpener and turn the pencil sharpener with one hand while supporting the other edge of the paper and that pencil with the other hand. A few trials will soon perfect the knack of rapid rerolling.—MARIE J. WARDEN, *Small Aircraft Engine Dept., General Electric Co., West Lynn, Mass.*

Do you have a helpful tip or technique for our other readers? You'll receive ten dollars or more for each published contribution. Send a short description plus drawings, tables or photos to: Tips and Techniques Editor, MACHINE DESIGN, Penton Bldg., Cleveland 13, O.

By David P. Wagner
Project Engineer
Shakeproof Div.
Illinois Tool Works
Elgin, Ill.

Plastic or rubber compounds, applied as mastics and cured in place, provide economical, easy-to-handle

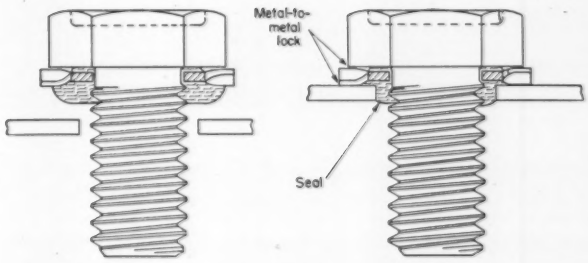


Fig. 1—Self-sealing tooth type lock washer. Cured mastic compound effects the seal, while the teeth bite through the mastic to provide a positive mechanical lock.

Self-Sealing Fasteners

MOST seals around fasteners are made by using rubber or synthetic washers, molded rubber grommets, or by "gobbing" or dipping the fastener or the area around it with some kind of sealing compound.

Much work has been done during the past few years to incorporate the sealing function into the fastener itself. This has many advantages, for it eliminates the necessity of handling extra parts and quite frequently eliminates an additional messy sealing operation. Leakage around fasteners caused by someone forgetting the seal is also eliminated since the seal is built right into each fastener. Sealing fasteners are generally neater in appearance, more compact, and more economical to use than are fasteners which must be sealed on the production line.

Since there are literally thousands of various sizes, shapes and forms of fasteners, a number of different methods have been devised to incorporate the sealing function into the fastener. A new way to accomplish this is to apply a mastic to the fastener which is then cured by applying heat to the assembly.

A number of compounds are available in the form of liquid latexes, plastisols, and vinyls which are flowed onto fasteners automatically and then cured or dried in place.

Sealing mastics applied to fasteners range in hardness from soft, putty-like materials to those

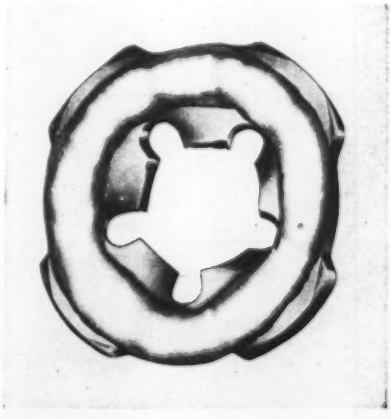
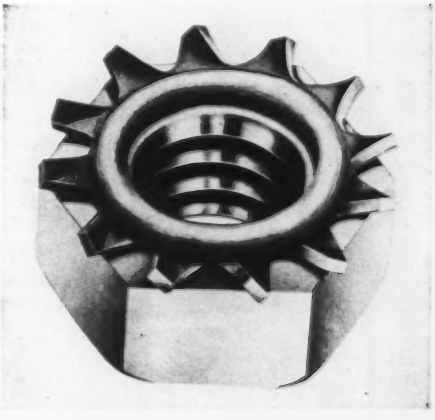


Fig. 2—Left—Dished lock washer with mastic seal for sealing and locking an auto tail light.

Fig. 3 — Right — Preassembled nut and lock washer with mastic compound seal.



as hard as 80 durometer rubber. Compounds also may be obtained which will seal against oil, gasoline, water and air over wide temperature ranges.

Design and Application: Proper design of a sealing fastener involves consideration of the amount of compound necessary to seal the hole, the approximate location of the compound on the fastener, and the conditions under which the compound must seal—whether oil, gasoline, water, detergent, and high or low temperature are present.

Flowing a ring of compound onto a fastener is a much less expensive process, but not quite as accurate as using a molded rubber or die-cut gasket. Dimensions of the mastic are usually given in terms of weight of compound per piece, with approximate dimensions for the location of the compound on the part.

Some means should be provided to compress the mastic to effect a seal, and at the same time have the fastener come in direct contact with the part it is holding. Since soft mastics have some tendency to cold flow under pressure, loss of tension in the fastener may result unless good contact has been established between the fastener and the workpiece.

Typical Fasteners and Uses: Sealing compounds applied to tooth-type lock washers, Fig. 1, present a new and unique approach in providing both a lock and a seal. The compounds adhere to the lock washer and can easily be handled in shipment. When the fastener is applied, the compound is compressed and completely fills the void between the screw thread, the lock washer and the work surface. At the same time, the tooth bites through the compound and provides metal-to-metal contact between the work surface, the lock washer, and the screw head (or nut).

A great number of variations of this locking and sealing combination can be designed. A large, dished lock washer lined with sealing mastic is used to seal and lock a tail light to a rear fender of an automobile, Fig. 2. Other manufacturers use the sealing lock washer idea but take it one step further by using "sealing Keps," in which the sealing lock washers are preassembled to nuts, Fig. 3. A typical use of this preassembled nut is in sealing medallions and trim molding clips on cars, Fig. 4.

The mastic-sealing tooth-type lock washer can

Fig. 4 — Mastic-sealed preassembled nut and lockwasher for fastening trim molding on an auto.

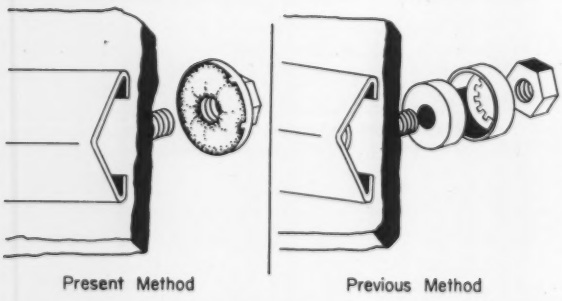


Fig. 5—Automobile trim-molding clips with sealing mastic applied.

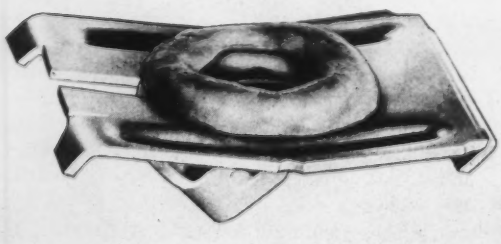


Fig. 6 — Thread-cutting screw with mastic seal.

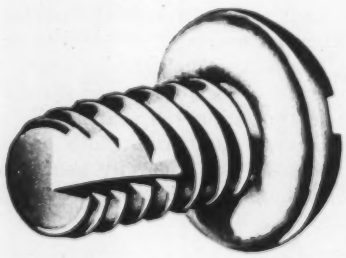
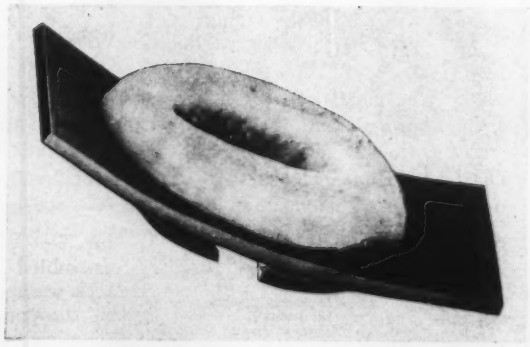


Fig. 7—Speed Nuts sealed with mastic.



also be preassembled to a screw. Applications for these "sealing Sems" can be found on almost all major appliances.

Sealing compounds also may be automatically applied to screw threads, eliminating hand-dipped or brushed-on methods of sealing. Applications for this type of product are often found in through-tapped holes which enter directly into a fluid chamber, as in gasoline motors, gear housings, water pumps, and radiators.

The application of sealing mastics to fasteners is not limited to lock washers, nuts and screws. For instance, automobile trim molding clips, Fig. 5, can have sealing mastics applied to them. Thread-cutting screws, Fig. 6, Tinnerman Speed Nuts, Fig. 7, and spring push-on stampings and jar lids also can be lined with sealing compounds.

In addition, sealing compounds can be applied to plastic fasteners. A good example is in sealing a polystyrene refrigerator shelf support. Several manufacturers of automatic driers are using nylon screw grommets which have been lined with sealing compound, Fig. 8.

More and more companies are using sealing fasteners to eliminate the sealing operation in their own plant. As compounds and methods of applying them continue to be improved, mastic sealing fasteners will play a continuingly more important part in the elimination of leakage.

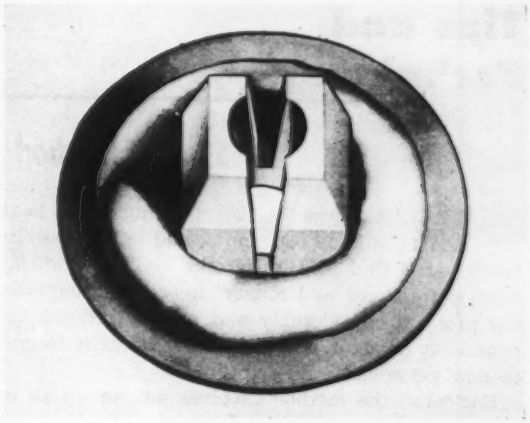
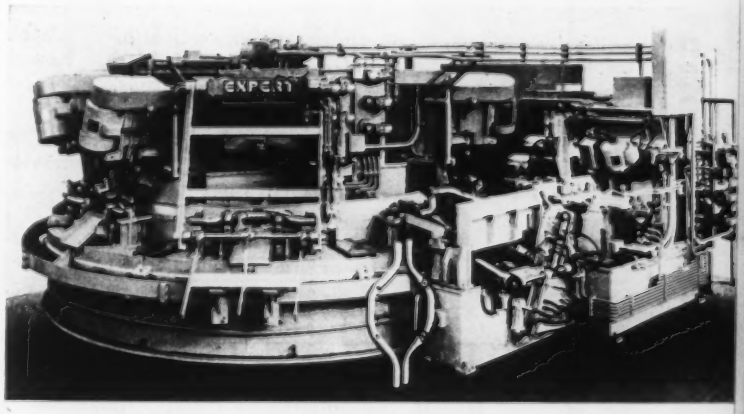


Fig. 8—Mastic sealer applied to plastic, in this case, a nylon screw grommet.

Contemporary Design

Die Cast Aluminum Saves Three Tons

USE of aluminum die castings for the 12-ft diameter indexing table of a recently announced automated drilling machine resulted in a 6000-lb weight saving. Low weight of the sectionalized, die-cast table allows a 2-hp motor to be used for indexing. Made by Expert Automation Machine Co., the machine combines features of an in-line transfer machine with those of a large center-column indexing machine to use minimum floor space. Electrically controlled and hydraulically operated, the machine drills, spotfaces, reams and deburrs holes in a 39-in. long, 2⅝-in. OD tubular steel automotive frame member. These operations are performed at four in-line and eight rotary stations on 200 pieces per hour.



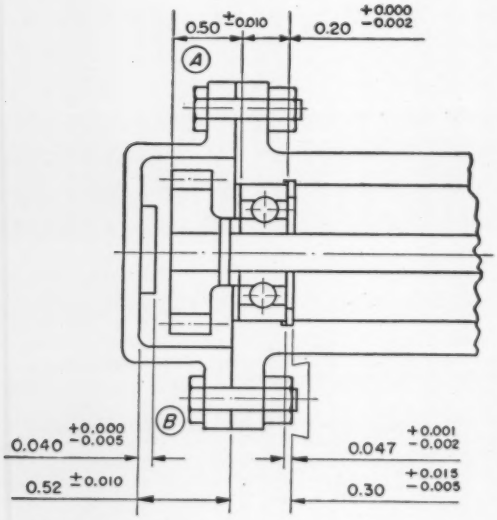
Tips and Techniques

Simple Method of Limit Checking

A FREQUENT method of checking limits is to add up all the top limits, add up the bottom limits and find the difference. The following method for "plus and minus" tolerances simplifies the problem considerably and greatly reduces the possibility of error. In addition, it is easily taught to new personnel.

Basically, the method involves adding up all of the nominal dimensions and tolerances running in one direction; adding up the nominal dimensions and tolerances running in the other direction; and finding the differences.

Clearance between gear *A* and internal housing face *B* is to be checked. First, draw two arrows



as shown in the table — to right and left for horizontal dimensions, or up and down for vertical dimensions. Starting at point *A*, note down nominal dimensions and tolerances, plus and minus. Place all of these under the arrow pointing to the right if

Nominal	High	Low
0.500	+0.010	−0.010
0.200	+0.000	−0.002
0.047	+0.001	−0.002
0.040	+0.000	−0.005
0.787	+0.011	−0.019

Nominal	High	Low
0.300	+0.015	−0.005
0.520	+0.010	−0.010
0.820	+0.025	−0.015
−0.787	+0.019	−0.011
0.033	+0.044	−0.026

Limits of clearance are 0.077 high to 0.007 low.

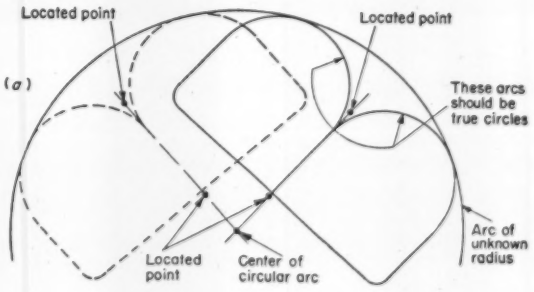
each nominal dimension runs to the right from the previous face in the "dimension circuit," or under the left-pointing arrow if the dimension runs to the left.

All columns are then added up and one set is subtracted from the other. Notice that the subtraction changes the sign of the plus tolerance to minus and vice versa, as shown by the bold-type numbers in the table.

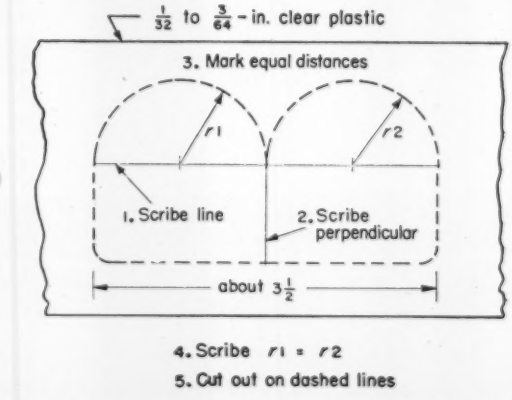
Sometimes a dimension will occur with double plus or minus limits, such as 0.5, −0.005, −0.003 or 0.4, +0.006, +0.002. Two treatments are possible: (1) convert to a single limit, such as 0.497, −0.003 or 0.402, +0.004 for the two examples above; or (2) put the figures right down in the columns, retain the original signs, and in adding the columns bear in mind the different sign. — J. BARKER and P. HANDS, *De Havilland Propellors, Hatfield, Hertfordshire, England*

Locating Arc Centers

THIS HANDY, home-made plastic gadget is an invaluable aid for locating the center of an arc of unknown radius. Four points are marked, *a*, and the lines connecting them intersect at the



center. Sketch *b* shows method of construction. — HAROLD E. BOETTGER, *General Motors Technical Center, Detroit, Mich.*



4. Scribe $r1 = r2$

5. Cut out on dashed lines

A guide to

Fastener Finishes

By Walton R. Yerger
Metallurgical Engineer
American Screw Co.
Willimantic, Conn.

PROPER selection of the fastener finish in each application may be governed by many factors such as cost, appearance, strength, corrosion resistance, and availability. Often the best choice of finish is the best compromise of these factors.

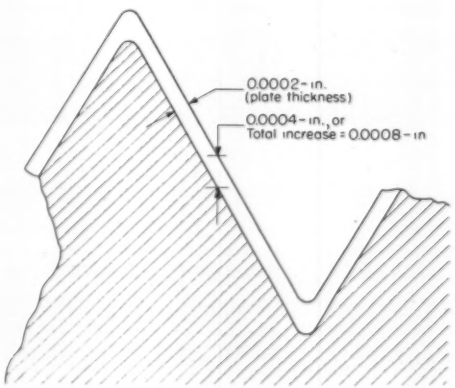


Fig. 1—Plated coating on an external screw thread showing build-up on pitch diameter.

Selecting the proper fastener finish requires that certain aspects of the application must be established:

1. Type of material, or plated surface of the mating parts.
2. Color or appearance required to match mating parts.
3. Physical aspects required that may limit the type of base metals.
4. Type of corrosion expected during service.

From knowledge of these requirements, an intelligent selection can be made of the most desirable finish at the lowest cost.

On applications such as appliances, indoor decorative trim, and other mild corrosion situations, the primary consideration is appearance. The decorative finishes are used to either match the mating surfaces or brighten the part for pleasing appearance and sales appeal. Since many of the so-called decorative finishes offer little corrosion protection, they are seldom used for outdoor and severe corrosion applications. For severe corrosion, such as marine hardware, only the finishes and base materials of high corrosion resistance can be considered for use.

When plated finishes are considered on threaded parts, the plated thickness is of paramount impor-

Table 1—Galvanic Series in Sea Water

Corroded End (anodic or least noble)
1. Magnesium and magnesium alloys
2. Zinc and zinc-plated steel
3. Aluminum (1100, 3003, 3004, 5052, 5053) and Alclad aluminum
4. Cadmium and cadmium-plated steel
5. Aluminum (2117, 2017 and 2024)
6. Mild steel (C1010, C1016, C1022)
   Alloy steel (2330, 3135, A4037, 4140 and 4340)
7. Ni Resist
8. Stainless steel, Type 410, 431 and 430 (active, not passivated)
9. Lead-tin (50-50) solder
10. Stainless steel, 18-8, Type 302, 304, 347
    Stainless steel, 16-18, Carpenter No. 10 (active, not passivated)
    Stainless steel, 18-8-3, Type 316 (active, not passivated)
11. Lead
    Tin
12. Muntz metal
    Manganese bronze
    Naval brass
13. Nickel (active, not passivated)
    Inconel (active, not passivated)
14. Yellow brass (70 copper, 30 zinc)
    Admiralty brass
    Aluminum bronze
    Red brass
    Copper
    Silicon bronze (Everdur)
    Ambrac
    Copper Nickel, 70-30
    G-Bronze
    M-Bronze
15. Nickel (passivated)
    Inconel (passivated)
16. Monel
17. Stainless steel, Type 410, 431 and 430 (passivated)
18. Stainless steel, 18-8, Type 304, 302 and 347 (passivated)
    Stainless steel, 16-18, Carpenter No. 10 (passivated)
    Stainless steel, 18-8-3, Type 316 (passivated)
19. Silver
    Graphite
    Gold
    Platinum

Protected End (cathodic or most noble)

tance because of the close tolerance of the threads. Heavy plate thickness cannot be tolerated since the plated layer on the threaded area will increase the dimension approximately four times the plated thickness. A thickness of 0.0002-in. on the screw head, which in most cases is the significant surface, increases the diameter of the screw shank 0.0004-in., and the pitch diameter 0.0008-in., Fig. 1. A plating thickness of 0.0003, 0.0004, and 0.0005-in. would increase the pitch diameter 0.0012, 0.0016, and 0.0020-in., respectively. The normal plating thickness tolerances resulting from the effects of the plating cycles, shading effects of the screw heads, etc., can produce an additional 25 per cent increase in the build-up of pitch diameter.

The pitch diameter tolerance for a class 2A fit external thread averages approximately 0.0030-in. Since only 30 per cent of this tolerance or 0.0010-in. is allowed for maximum plating build-up, plating thicknesses greater than approximately 0.0002-in. are not generally practical from a gaging standpoint. For plating thickness greater than 0.0002-in., special undercut threads are necessary to allow for the build-up on the pitch diameter.

Galvanic Corrosion: When two unlike metals are connected to each other in an electrolyte, galvanic corrosion occurs. An electrolyte can be sea, salt or fresh water, acids, or any liquid which will conduct an electrical current. The electrical current set up by the two metals passes from the anode through the electrolyte and is spent or deposited on the cathode. No corrosion occurs at the cathode; thus, the anode material is destroyed and the cathode material is relatively unattacked.

The magnitude of corrosion on the anode depends upon the electrical potential between the two metals. The galvanic series shows the tendency of metals and alloys to form significant galvanic cells and the probable direction of the galvanic effects. These metals and alloys may be divided into groups which have little or no tendency to produce galvanic corrosion to each other. The coupling of two metals from different groups and distant from each other in the list will frequently result in galvanic or accelerated corrosion of the less noble (anodic) metal. The farther apart the metals stand in the series and the stronger the electrolyte, the greater will be the galvanic tendency and severity of corrosion. Table 1 lists the relative position of metals and finishes with respect to their galvanic tendencies in sea water.

As the ratio of cathode area to anode area increases, the corrosion rate increases. Therefore, it is advantageous to keep the cathode material area small and the anode area large. Thus, the fastener material or finish should be cathodic to the metals in the joint to minimize corrosion and favor the joint strength.

To prevent or minimize galvanic corrosion, the following recommendations are suggested:

1. Select combinations of metals as close together as possible in the galvanic series.

2. Avoid making combinations where the area of the less noble material is relatively small.

3. Insulate dissimilar metals wherever possible. If complete insulation cannot be achieved, anything such as paint or plastic coating at joints will help increase the resistance of the circuit and minimize corrosion. Anodizing aluminum, using insulating washers and sleeves between fastener and sheet, lacquering, or applying post treatments such as chromates have the effect of insulating the metals and minimizing the galvanic potentials and the resultant corrosion.

4. Apply coating with caution. For example, do not paint the less noble (anode) material without also coating the more noble (cathode) material. Otherwise, greatly accelerated attack may be concentrated at imperfections in coatings on the less noble material. Keep such coatings in good repair.

5. In cases where the metals cannot be coated and are connected by a conductor external to the liquid, the electrical resistance of the liquid path may be increased by designing the equipment to keep the metals as far apart as possible.

6. If practical, add suitable chemical inhibitors to the corrosive solution.

Table 2—Relative Corrosion Resistance to Salt Spray

Stainless steel, Type 304	(unlimited)
Hot dip galvanize	100
Cadmium, 0.0005-in., plus dichromate (Cronak)	82
Cadmium, 0.0005-in., plus chromate (Bright Iridite)	75
Cadmium, 0.0003-in., plus dichromate	72
Aluminum, anodized	62
Cadmium, 0.0005-in.	60
Cadmium, 0.0003-in., plus chromate	50
Zinc, 0.0005-in., plus dichromate	50
Cadmium, 0.0002-in., plus dichromate	48
Cadmium, 0.0003-in.	48
Zinc, 0.0003-in., plus dichromate	44
Zinc, 0.0005-in., plus chromate	37
Zinc, 0.0002-in., plus dichromate	37
Zinc, 0.0003-in., plus chromate	25
Cadmium, 0.0002-in., plus chromate	25
Zinc, 0.0005-in.	25
Cadmium, 0.0002-in.	24
Phosphate coating, chemically treated and waxed	24
Hot tin dip	20
Zinc, 0.0003-in.	19
Zinc, 0.0002-in.	12
Stainless steel, Type 430	10
Nickel: 0.0002-in. copper, 0.0003-in. nickel	10
Chromium: 0.0002-in. copper, 0.0003-in. nickel, 0.000025-in. chromium	10
Stainless steel, Type 431	9
Phosphate coating (special), oiled	9
Nickel, 0.0004-in.	8
Nickel: 0.0002-in. copper, 0.0002-in. nickel	8
Chromium: 0.0004-in. nickel, 0.000025-in. chromium	8
Chromium: 0.0002-in. copper, 0.0002-in. nickel, 0.000025-in. chromium	8
Aluminum	6
Stainless steel, Type 410	6
Nickel, 0.0003-in.	6
Chromium: 0.0003-in. nickel, 0.000025-in. chromium	6
Electrogalvanizing, 0.0003-in.	6
Phosphate coating (regular), oiled	6
Black oxide, oiled	4
Nickel, 0.0002-in.	4
Copper, 0.0002-in.	4
Chromium: 0.0002-in. nickel, 0.000025-in. chromium	4
Electrogalvanize, 0.0002-in.	4
Brass, 0.0002-in.	4
Tin, 0.0002-in.	4
Phosphate coating, dry	2
Black oxidize	1

Other Types of Corrosion: Fasteners can be subjected to all types of corrosion ranging from mild indoor exposure to severe acid or alkali atmosphere. Even with the best information on service conditions, it is impossible to predict definitely the severity of corrosion which might be expected on any particular application. However, guides to the relative corrosion resistance of metals and coatings for a particular atmosphere are available and can be helpful in the selection of a suitable finish. One of the most common guides is the relative salt-spray resistance. Table 2 is a list of the various metal, plates and finishes rated according to their resistance to the corrosion effects of salt spray or marine type atmosphere. The table takes into consideration the effects of galvanic corrosion but it does not apply to other atmospheres such as industrial or those acidic in nature.

Types of Finishes: There are numerous types of finishes used for fasteners. These finishes vary in appearance, corrosion resistance, and cost. Table 3 lists some of the more common finishes.

Table 3—Common Finishes for Fasteners

Finish	Appearance	Anticorrosion Properties	Suitability	Characteristics and Uses
Aluminum (surface treatments on aluminum parts)	Frosty-etched (plain or anodized)	Excellent if anodized	Aluminum	A chemically cleaned surface for decorative use.
	Burnished (semilustrous—plain or anodized)	Excellent if anodized	Aluminum	A mechanically cleaned surface for decorative use.
	Very bright (lustrous—plain or anodized)	Excellent if anodized	Aluminum	A chemically polished surface for decorative use.
Anodized, Plain	Silver-gray (also can be colored)	Excellent	Aluminum	An acid electrolytic treatment for aluminum which produces a hard oxide surface that affords good protection from marine corrosion. Colored coatings used extensively for decorative purposes.
Antique Copper (see *Copper, Brass, Bronze, Misc. Finishes*)				
Antique Silver (see *Silver Plate*)				
Black Oxide (Blued)	Black (oiled or waxed)	Indoor, satisfactory; outdoor, very poor (corrosion protection afforded mainly by oil or wax coatings)	Steel	A hot alkali chemical process to produce a rust-inhibited surface similar in appearance and characteristics to *Blueing*. Blue-black to black in color.
Black Chromate	Black (semilustrous)	Added corrosion protection on cadmium and zinc-plated surfaces	Zinc-plated or cadmium-plated steel	A chemical dip, good for outdoor decorative purposes. Can be lacquered.
Black Nickel (see *Nickel Plate*)				
Blueing	Blue to black (may be oiled or waxed)	Indoor, satisfactory; outdoor, poor (protection afforded mainly by oiled or waxed coatings)	Steel	A coloring process produced by heat tinting. Principally for decorative use. Appearance is similar to black oxide.
Brass				
Matte Brass (laquered)	Dull satin	Good	Brass	Mechanically or chemically cleaned surface. Decorative finish for indoor use only.
Polished Brass (lacquered)	Smooth, lustrous	Good	Brass	Fine buffed surfaces. Decorative finish for indoor use only.
White Diamond (lacquered)	Fine satin	Good	Brass	Brushed or coarse buffed surface. Decorative finish for indoor use only.
Brass Plate (lacquered)	Brass	Fair	Steel, usually	An electroplated decorative finish used to match brass. Recommended for indoor use only.
Bronze Plate (lacquered)	Similar to 80% copper, 20% zinc alloy	Fair	Steel, usually	An electroplated decorative finish used to match bronze. Recommended for indoor use only.
Burnished Surfaces	For most metals, semibright to lustrous depending upon metal)	Same as for metal	Most metals	Mechanical preparation of metal surface by ball burnishing.
Butler Finishes	Coarse satin to medium fine	Same as for metal	Chromium, nickel, stainless steel, brass, etc.	Composed of fine parallel lines produced by wire brushing or buffing.
Cadmium Plate				
Standard	Bright silver gray	Very good	Most metals	An electroplated finish for corrosion protection and decorative use.
Spartan Gray	Dull gray			
Black Cadmium (lacquered; also see *Black Chromate*, a similar finish)	Black			
Chromate Finishes		Very good to excellent	Cadmium-plated and zinc-plated parts	A chemical conversion coating applied to freshly plated zinc or cadmium surfaces for added corrosion resistance, coloring and paint bonding. The colored chromate coatings usually have greater corrosion resistance than the clear bright.
Clear Dichromate	Clear bright; iridescent Yellow, brown, green; iridescent			
Olive Drab, Gold or Bronze	Green, gold or bronze tones			
Chromium Plate	Bright blue-white	Good (improves with increased copper and nickel)	Most metals	A bright lustrous electroplated finish used extensively for ornamental and decorative purposes in hardware, appliances and automotive parts. Produces a relatively hard surface.
Copper Plate (also see *Copper, Brass, Bronze, Misc. Finishes*)	Copper (may also be blackened and relieved to obtain Antique, Statuary, and Venetian finishes)	Fair	Most metals	An electroplated finish commonly used as an undercoat for nickel and chromium plate.

XUM

Table 3—(Cont.) Common Finishes for Fasteners

Finish	Appearance	Anticorrosion Properties	Suitability	Characteristics and Uses
Copper, Brass, Bronze, Misc. Finishes	Colors and tones vary from black, through a series of mottled tones, to almost the original plated surface with just a cast of brown or black in the low spots	Indoor, very good	Most metals	Decorative finishes, applied to copper, brass, and bronze-plated parts for matching colors. Names of some of the more standard finishes are: Antique, Copper Oxidized, Black Oxide, Old English, Statuary, and Venetian.
Dull Nickel (see *Nickel Plate*)				
Galvanizing (see *Zinc*)				
Lacquering	Clear or colored to match mating color or luster	Generally improves corrosion resistance. Some types are specifically designed for humid or other severe applications	All metals	Most commonly used on decorative finishes.
	Tone finishes: gold (brass), silver (aluminum), copper, etc.	Fair to good	Steel, usually, or may be applied over plated parts	Color-matching decorative finishes which use metallic bronzing powders of very fine mesh mixed with a clear lacquer for vehicle.
Lead-Tin	Silver gray (dull)	Fair to good	Steel, usually	Applied by the hot-dip method, lead-tin affords good lubrication on tapping screws.
Nickel Plate				
Bright Nickel	Silver	Indoor, excellent; outdoor, good if thickness approximates 0.0005-in.	Most metals	An electroplated finish used for hardware, appliances, and as an undercoat for chromium.
Dull Nickel	Whitish cast	Same as bright nickel	Most metals	Obtained by either a special plating bath or mechanical finishing of the surface.
Black Nickel (lacquered)	Dull black	Recommended for indoor use	Most metals	Decorative finish for hardware and appliances.
Passivating	Same as base metal	Excellent	Stainless steel	A chemical treatment applied to remove contaminating iron particles and to produce a passive film on the surface.
Phosphate Coatings				
Bearing Surfaces (Army 57-0-2 Type II Class A)	Black	Good	Steel	Antichafing properties used on sliding or bearing surfaces. Black manganese-iron phosphate coating with nondrying petroleum oils containing corrosion inhibitors.
Rust Preventive (Army 57-0-2 Type II Class B)	Plain grayish surface over which may be applied rust-preventive oils	Fair to good	Steel	A chemical process for rustproofing steel (zinc-iron phosphate and chromate post treatment).
	Dyed black plus rust-preventive oils	Good	Steel	Rust-preventive oils increase resistance to corrosion.
Paint-Base Preparation (Army 57-0-2 Type III Class C)	Plain gray	Good after paint or lacquer applications	Steel, aluminum, zinc plate	A chemical process for preparing steel, aluminum, and zinc-plated parts for painting or lacquering. Greatly increases bond between metal and coating.
Coloring	Various: green, red, black, blue, purple, gray, etc.	Superior to regular phosphated and oiled surfaces	Steel	A colored coating produced chemically on a "phosphated" surface for added corrosion resistance.
Rust Preventives	Varies in film thickness and color	Varies with function of oil	All metals	Applied to parts for protection in prolonged storage or transit; also for lubrication or outdoor exposure. Rust preventives are usually applied to Black Oxide and Phosphate finishes.
Silver Plate	Silver	Excellent	All metals	An expensive decorative finish with excellent corrosion protection and electrical conductivity.
	Antiqued silver; black with silver highlights (laquered)	Very good	All metals	A modified plate used for decorative purposes.
Spartan Gray (see *Cadmium Plate*)				
Statuary Finishes (see *Copper, Brass, Bronze, Misc. Finishes*)				
Tin				
Electroplated	Silver gray	Excellent	All metals	Excellent corrosion protection for parts in contact with food.
Hot-Dip Tin	Silver gray	Excellent	All metals	Same as electroplated tin except that thickness is more difficult to control, especially on fine-thread parts.
Tone Finishes (see *Lacquering*)				
Venetian Bronze (see *Copper, Brass, Bronze, Misc. Finishes*)				
White Diamond (see *Brass*)				
Zinc				
Electroplated	Bright: blue-white gray	Very good	All metals	Used for corrosion protection of steel parts; on other metals for coloring and matching purposes. Used for parts in contact with food.
	Dull (electrogalvanized)	Very good	All metals	Used where bright appearance can not be tolerated.
Hot-dip	Dull	Very good	All metals	Used where thickness of coating is not important dimensionally but maximum corrosion resistance is essential. Corrosion resistance is directly proportional to zinc thickness.
Black zinc (lacquered)	Black	Very good	All metals	For decorative effects. Zinc chromate post treated.

Design Considerations for

Drawn Titanium Parts

By James S. Kirkpatrick

Vice President
Research and Development
Brooks & Perkins Inc.
Detroit

MOST of the titanium used up to the present has been commercially pure titanium. Newer alloys of titanium have been a welcome material since they weigh about one-half as much as steel alloys, yet have comparable strength. With the addition of alloying materials, titanium has followed the characteristics of other metals, in that the alloys are somewhat more difficult to form.

Complexity of current titanium components is shown in Fig. 1. This part is for a jet engine and requires extreme dimensional control, both in the formed parts and in the finally machined assembly. Fig. 2 shows the forming required in segments of the side member prior to final welding and machining.

Titanium channels, Fig. 3, have been formed in two sizes, approximately fifteen pieces each. These pieces were formed without any scrap being generated. Benign cracks would probably have occurred in a great many pieces if this operation had been attempted at room temperature. This illustrates one of the potentials of elevated-temperature forming, re-

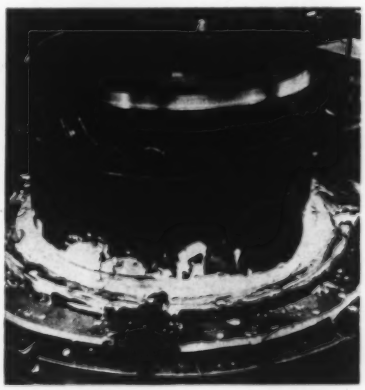


Fig. 1 — Jet-engine part made of welded titanium components.

Fig. 2 — Components of assembly pictured in Fig. 1, showing forming required prior to final welding and machining.

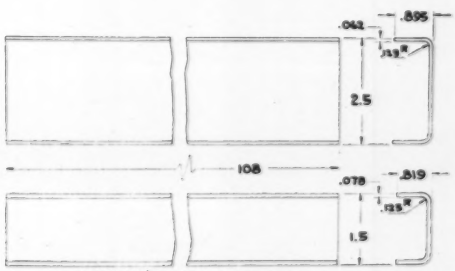


Fig. 3 — Titanium channels formed hot on a press brake.

duction of scrap.

In 1954, Brooks & Perkins developed a rather simple cupping die in which to determine the drawability of the commercially pure titanium at elevated temperatures. Shown in Fig. 4 is the configuration of this cup. It was 3 in. in diameter, and the first attempt allowed the 55,000-psi yield-strength material to be drawn to a depth of 5 in. Any material that would yield a cup of this type would be capable of being formed into most of the shapes desired at this time.

Fig. 5 shows various deep-drawn parts which have been accomplished in the indicated titanium material.

Spinning at elevated temperatures on titanium is shown in Fig. 6. It should be noted that this shallow cup has been spun to shape, and then a reverse flange added to the part. While most of the shapes required in commercially pure titanium have been spun, attempts at hot-spinning the alloy titaniums have not been successful.

Cross section of the flange on the jet-engine part which was seen in Fig. 2 is shown in Fig. 7. This part required a square welding flange. The radius is formed, and then the welding flange is formed as a blend from the radius. A normally severe radius would probably cause cracking in titanium alloys. The material used in this case is Rem-Cru A-110-AT titanium alloy.

In Fig. 8 is shown a third of a circle flange also manufactured from the Rem-Cru A-110-AT material. Three of the parts are welded together to form a complete circle which is fabricated into a jet-engine assembly. This type of alloy

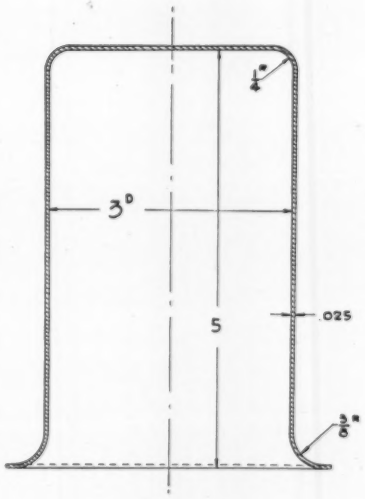


Fig. 4—Cup made of titanium deep drawn hot in one operation.

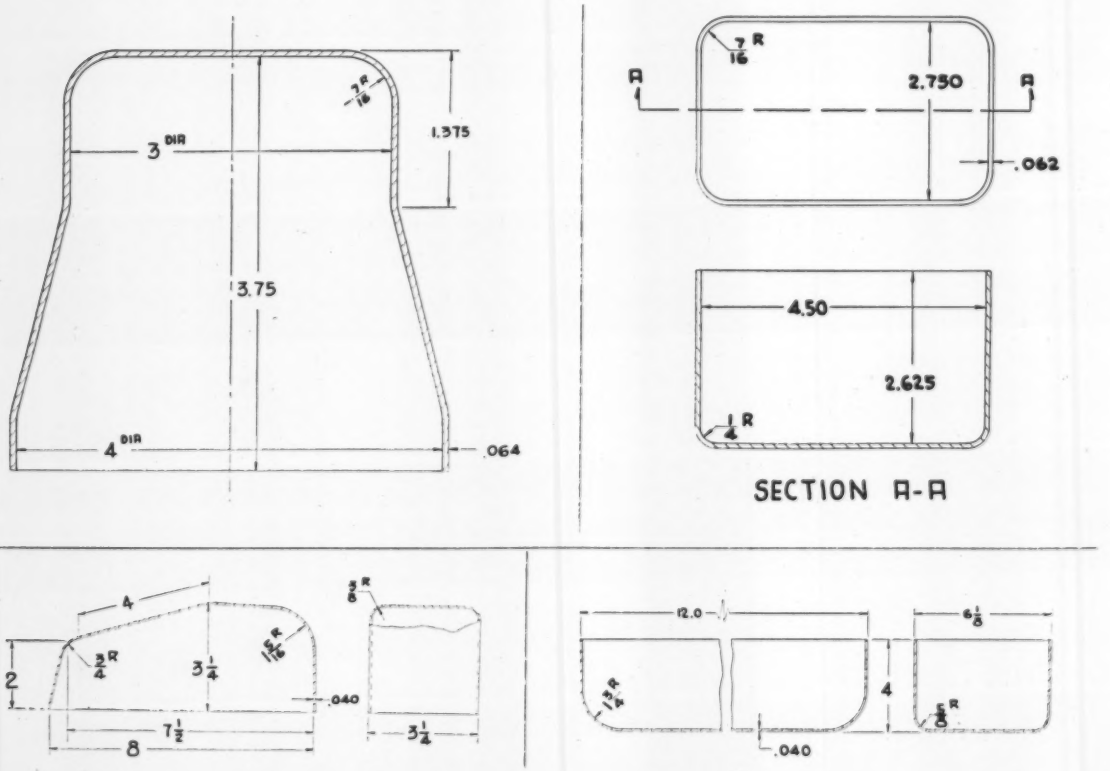


Fig. 5—Sections through four parts deep drawn hot from AMS 4901 (A-70) titanium in one operation.

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Circle 571 on page 19

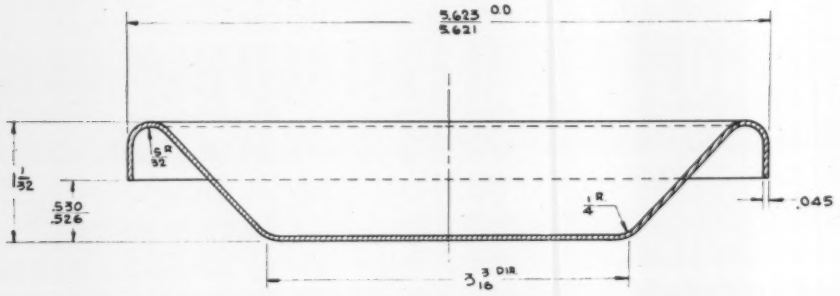

Fig. 6—Titanium part formed by spinning.

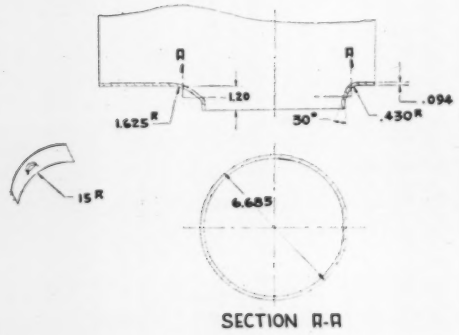

Fig. 7—Cross section of flange on the jet-engine part shown in Fig. 2.

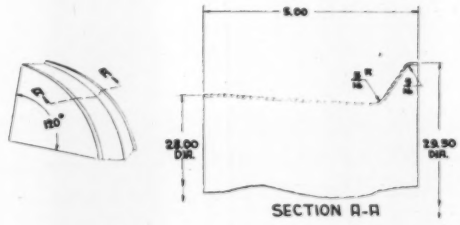

Fig. 8 — Circular flanged section of titanium alloy formed hot in one operation. Three of these parts are welded together to form a complete circle.

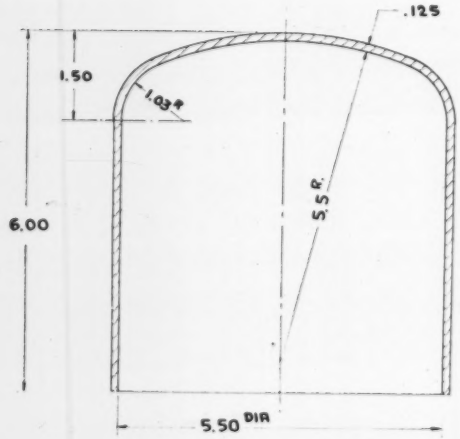

Fig. 9 — Section through half of a high-pressure vessel drawn from titanium alloy.

has excellent weldability.

A section through one-half of a highly pressurized vessel drawn from RS-110-BX titanium alloy is shown in Fig. 9.

The cover for a jet-engine accessory case, Fig. 10, is to be operated in the temperature-affected zone of the jet engine. One corner of this cover is very sharp, yet this part was drawn to a depth of almost 4 in.

All subsequent operations on formed titanium parts, such as cutting, turning, milling, drilling, reaming, counterboring, tapping, threading, filing, grinding, buffing and dust collection, offer no problem if the current available literature is followed. Blanking dies have been made for secondary

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operations. Experience is limited to gages under 0.064-in. No difficulty has been experienced on blanking or piercing. Parts have not been in service long enough to make any determinations as to possible notch failure, but preliminary laboratory tests indicate that this should not occur. No greater difficulty should be experienced in carrying out secondary operations on titanium than has been experienced in many of the stainless steels and high-alloy steels.

Limited forming techniques, using the stretch press, have been successfully accomplished. The form blocks used in stretching have been made of cast iron. When stretch-press operations are planned on titanium, the amount of material required for the gripper jaws should be taken into account. At the current cost of titanium and titanium alloys, it is believed that draw dies become more economical at a much lower quantity rate than in other metals.

As with other metals which have been severely worked or welded, residual stresses are developed. A stress-relief treatment should probably be defined as a heat treatment which will relax the residual stresses caused by cold or warm working. When titanium is worked at elevated temperatures, less stresses are developed. However, on highly stressed parts, stress relief is accomplished as a precaution. This stress relief should be done in a vacuum furnace for approximately one hour at 1000 to 1150 F. Stress relieving at temperatures above 1200 F should be avoided. If the part were exposed to temperatures higher than 1200 F, formation of unwanted beta crystalline structure would occur. During the service life of the titanium part, the beta structure could decompose, and the parts might be seriously embrittled.

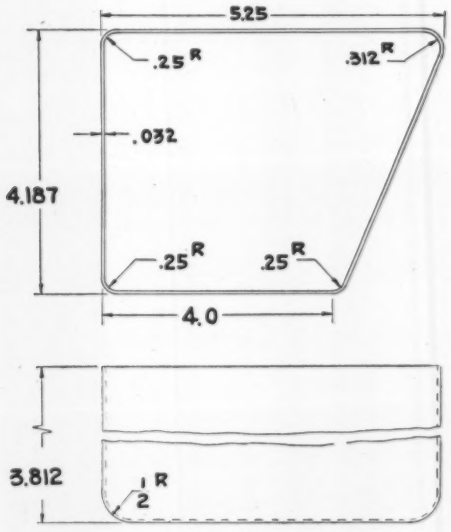

Fig. 10—Cover for a jet-engine accessory case.

From a paper entitled "The Drawing of Titanium" presented at the ASTE Annual Meeting in Chicago, March, 1956.

Organizing engineering for

Designing and Manufacturing

By W. P. Smith

Assistant Professor of Mechanical Engineering
Michigan State University
East Lansing, Mich.

DUTIES of the total engineering function within a manufacturing organization are illustrated graphically in Fig. 1. The total engineering job consists of translating the often nebulous wants and desires of potential customers into concrete plans and specifications which, when followed, will result in a product so acceptable to the customer that he will be willing to buy it in preference to other competing alternatives.

Engineering is essentially concerned with design. Engineering activity results in specifications which are given to manufacturing. There are three essential sets of specifications needed by manufacturing in order to satisfy the customer fully:

1. *Product design specifications* which describe with words, pictures, symbols, etc., the size, shape, weight volume, strength, surface finish and other physical and chemical characteristics of the product. These are the specifications that establish the purpose of the product or the job the product will do, as well as the quality of the product and what the product will look like.

2. *Production design specifications* which describe with words, pictures, symbols, etc., the machines, tools, operators, space, motion patterns, etc. required to produce the product. In effect, these are the specifications that establish the methods, and to a great extent the cost, of manufacturing the product, and the price the customer must pay.

3. *Manufacturing schedule specifications* which describe with words, pictures, symbols, etc., when various steps in the manufacturing procedure should be carried out

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Set Screw News

& Mfg. Co.

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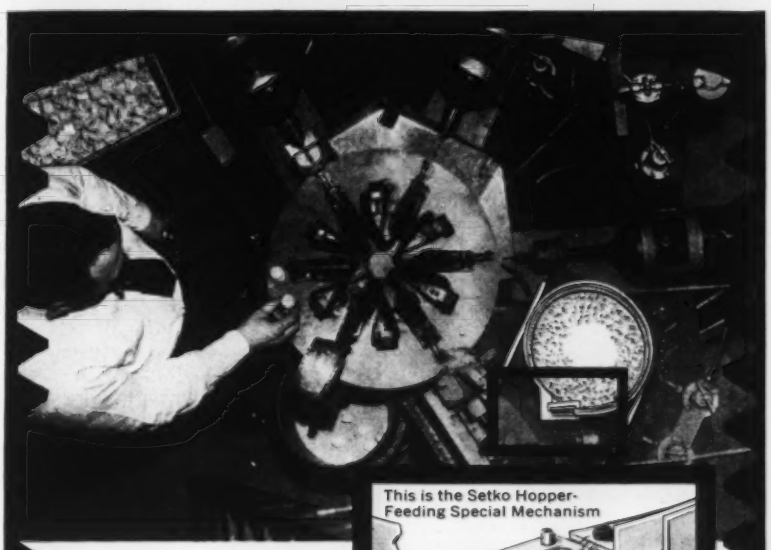
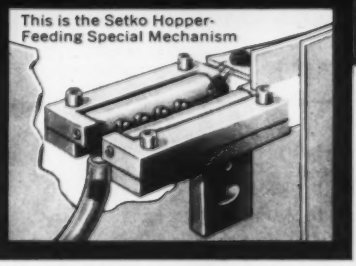
Issue No. 5 Bartlett, Illinois (Chicago Suburb)

Free Demonstration Shows How to Cut Costs with SETKO HOPPER-FED* Headless Set Screws



This is the Setko Hopper-Feeding Special Mechanism



How Rogan Bros. uses Setko Method of Hopper-Feeding Set Screws in its Automation of Drilling, Tapping and Inserting

Above is a typical Setko Hopper-Feeding Set Screw installation, showing its use with special equipment designed and used by Rogan Bros., Skokie, Ill., to drill and tap plastic knobs and insert set screws automatically in sequence. With this Setko method only one machine is required in place of three, and half the number of operators. This is one of many Setko Hopper-Feeding applications.

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Flush-Lok Self-Locking
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Many Unusual Advantages

- Requires about one-tenth the time of former methods of headless set screw application as proven by actual test.
- Automatically inspects diameter and rejects misfits.
- Works equally well with all metals and with plastics.
- Takes less floor space and permits smaller set-screw inventory.
- Can be used for practically any headless set screw application, including the new Setko Self-Tapping.
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- Makes possible faster delivery.
- Can be obtained with any style point.

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A step further toward ever-growing "automation"! The new, specially designed Setko Hopper-Fed Set Screws are mechanically fed from a vibrating hopper, down through a tube, and automatically positioned for driving. (See illustration at left.)

Mechanism and Demonstration

This special mechanism has been designed by Set Screw & Mfg. Co. exclusively for users of its new Hopper-Fed Headless Set Screws . . . and for its customers' protection, the mechanism and screws will be sold only to work in conjunction with each other. To show the many advantages of this new process, demonstrations of the hopper mechanism and screws are being made at the Set Screw & Mfg. Co. plant and arrangements will be made for anyone who wishes to come and see the demonstration.

Get Full Details

Learn *all* the time-and-money-saving advantages that the new Setko Hopper-Fed Headless Set Screws can bring you; find out how easy it is to have a demonstration. Don't bother to write a letter or even a postcard. Simply . . .

SET SCREW & MFG. CO., 28 Main St., Bartlett, Ill.

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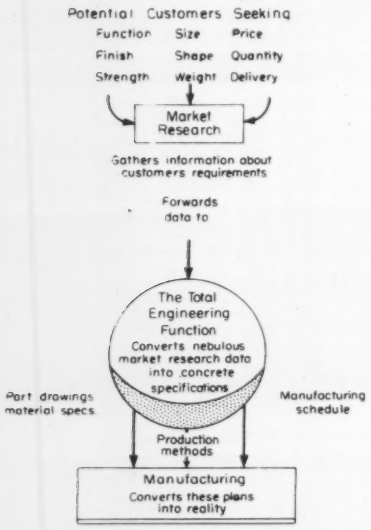

Fig. 1—Total engineering function within a manufacturing organization.

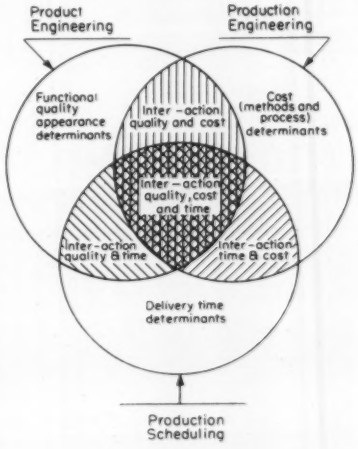

Fig. 2—Functional subdivision of total engineering job.

during the day, hour, month, etc. These are the specifications that determine when the product will be ready for delivery.

It would appear reasonable, if the total engineering activity must be subdivided at all, that a division based upon the three major types of specifications required in manufacturing would be a logical means of subdivision to achieve desired coordination and smooth functioning organization, Fig. 2.

From a paper entitled "Steps Toward More Creative Production Engineering" presented at the ASME Semi-Annual Meeting in Cleveland, June, 1956.

Engineers and Scientists

SCIENTISTS and engineers must be blended into an effective team. To better understand the use of scientists and engineers, it is best to start with some firm definitions. Engineers and scientists are not particularly different in their education today; this was not true 20 years ago.

Both are now educated in the scientific facts of Nature and trained in exact mathematical methods. Both require a highly developed curiosity about the physical universe, properties of materials, mathematical formulations, and the working of machines and electrical circuits. Also, both would be expected to be equally gifted in good judgment and the ability to separate relevant from irrelevant, and have a strong desire to create or discover something new and important.

If then a scientist and an engineer are so much alike, what is different? The difference is in their motives. Consider two men of equivalent background and training, if one of them creates original systems or builds something new, he is an engineer. If, on the other hand, he inquires into the why of things and tries to relate it to known fundamental laws, or formulate problems that bear upon still unknown laws, he is a scientist.

Simply stated, given the same capabilities, the engineer desires to build something and make it go, and the scientist desires further explanation and discovery.

Progress requires properly integrated efforts of people in both of these fields.

From a paper by R. C. Sebold entitled "The Challenge of Progress" presented at the ASME Aviation Conference in Los Angeles, March, 1956.

New Frame Sizes

New NEMA frame sizes for ac motors, as shown in Table 1 of "New NEMA Standards for AC and DC Motors," Page 122, July 12, 1956, should be corrected for totally enclosed, fan cooled, 55 C, 60 cycle motors, Designs A & B, as follows: the 20-hp motor should have frame size 286-U; the 25-hp motor, frame size 324-U; and the 30-hp motor, frame size 326-S.

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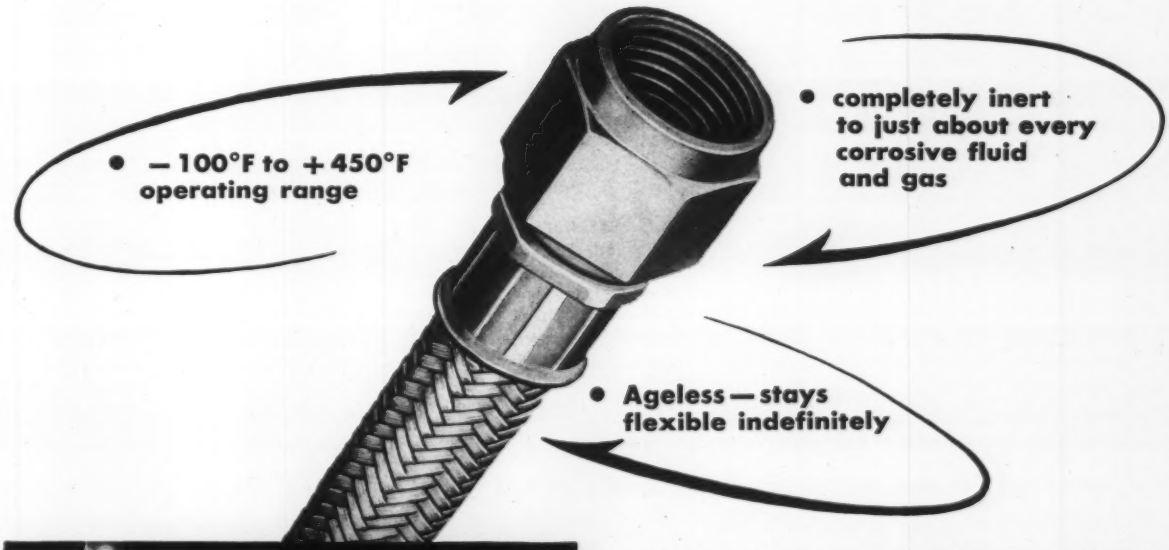
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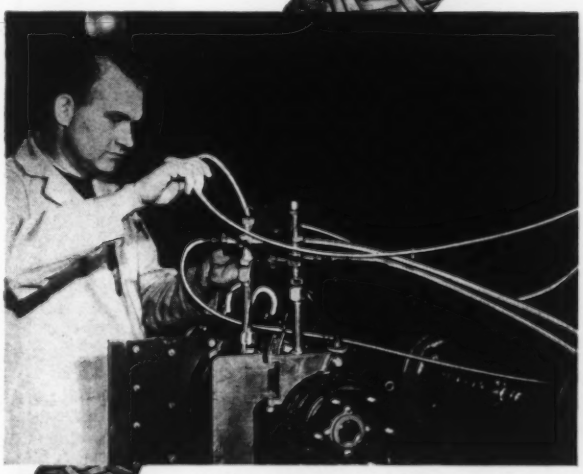

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Circle 573 on page 19

HELPFUL LITERATURE
for Design Executives

For copies of any literature listed, circle number on Yellow Card—page 19

Multiple V-Belt Sheaves

Tabulated in catalog MVD-56 are design and application data on the complete line of Ful-Grip Q-D sheaves, standard Multi-V sheaves and custom-made sheaves. Dimensions are given for A, A-B, C and D-section sheaves, together with information on bushings. Also covered are straight or crowned face pulleys. 16 pages. Maurey Mfg. Corp.

Circle 401 on page 19

Alloy Castings

Castings developed expressly for heat and corrosion resistant service are covered in well-illustrated catalog. Information is included on principles of alloy composition, properties and limitations, stabilizing influences and heat treatment. Typical castings produced to users' needs are shown. 16 pages. Michigan-Standard Alloy Casting Co.

Circle 402 on page 19

Mobile Hydraulic Systems

Oil-hydraulic systems and components for all mobile equipment in truck and bus, construction machinery, material handling, agricultural and allied industries are described in illustrated bulletin M5101A. Performance and design data are given on pumps, power packs, valves and controls, reservoirs, fluid motors and power steering boosters. 20 pages. Vickers Inc.

Circle 403 on page 19

Battery Truck Motor

Design, construction and application features of a new traction motor for low-voltage electric vehicles are given in bulletin GEA-6532 along with performance, rating and mounting data. Motors are rated 1 to 2 hp, 1000 to 2400 rpm and operate on 12, 24 and 36 v dc. 6 pages. General Electric Co.

Circle 404 on page 19

Hydraulic Hose Selector

Revised selector for rubber covered hydraulic hose contains latest SAE and industry specifications. Starting with any known factor such as inside or outside diameter, minimum burst, working pressure required or bend radius, user can determine proper Wiretex hose for his needs. Lee Rubber & Tire Corp., Republic Rubber Div.

Circle 405 on page 19

Self-Locking Fasteners

Nylon plug imbedded permanently in threaded section constitutes locking principle of Nylok one-piece self-locking fasteners. These fasteners can be applied to any male or female threaded part. Condensed catalog 11B provides complete data on line of these fasteners. 12 pages. Nylok Corp.

Circle 406 on page 19

Variable Speed Drive

Advantages of the Vari-Mount variable speed motorized drive are pointed up in folder JA. Drive affords 1 to 15 hp, uses standard motor and provides up to 6:1 variation. Maximum speeds range from 711 to 15.1 rpm. 4 pages. Foote Bros. Gear & Machine Corp.

Circle 407 on page 19

Office Copier

The Dial-A-Matic all-purpose copy-maker described in folder will copy photographs, blueprints, or anything written or drawn by any medium, or anything printed by any process. Copies are made from any type paper and card stock. 4 pages. American Photocopy Equipment Co.

Circle 408 on page 19

Industrial Grease

Technical bulletin 46 describes Sun C-891T grease for lubricating open gears, sprockets, chains, cams, couplings, slides, cables and linkages. It stays put under the worst operating conditions. 1 page. Sun Oil Co.

Circle 409 on page 19

Standard Alloy Fasteners

Pocket-size catalog describes bolts, nuts, rivets, screws, washers and other standard fasteners fabricated in stainless steel, Monel and super alloys. 28 pages. Albany Products Co.

Circle 410 on page 19

Unified Threads Explained

Quick explanation of unified screw threads is given in simple language along with helpful illustrations in this folder. It cites profile origins of unified threads adopted in 1948, the minor changes in threads-per-inch from American Standards and advantages of thread tightness and interchangeability. 4 pages. Cleveland Cap Screw Co.

Circle 411 on page 19

Sprayable Plastisol Coatings

Unichrome Super 5300 plastisol coating can be sprayed up to 60 mils thick in a single application, even on vertical surfaces. It is described in illustrated bulletin SP-1 as resistant to a wide range of acids, alkalies, salt solutions and chemicals. 4 pages. Metal & Thermit Corp.

Circle 412 on page 19

Grooved Pins & Studs

A helpful reference to design engineers for selecting Groov-pin fasteners is provided in company brochure. Booklet shows typical applications, lists standard sizes and presents test data along with dimensions and material specifications. 32 pages. Groov-Pin Corp.

Circle 413 on page 19

Dihedral Couplings

Designed to handle angular and offset misalignment up to 12 degrees, series D-100 standard, floating shaft and mill motor type dihedral couplings are descriptively covered in catalog 62. Working data on sizes, capacities and dimensions are given. 8 pages. Ajax Flexible Coupling Co.

Circle 414 on page 19

Thermosetting Adhesives

Literature offered in single bound folder on Tygoweld thermosetting adhesives includes an instruction booklet TG-19R for bonding similar and dissimilar materials, a general properties chart, bulletin TG-105 on comparative advantages and TG-106 summarizing recommendations for joint design. 30 pages. U. S. Stoneware Co.

Circle 415 on page 19

Gearhead Motors

Standard BYLM permanent magnet type gearhead motors, subject of illustrated catalog F 4344-3, have 5 to 10 lb-in. maximum torque outputs. Motors range up to 1/10-hp and

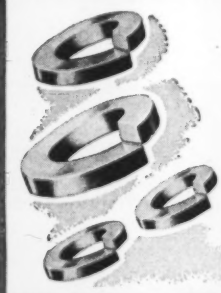
If You Need

SMALL PARTS IN A HURRY

plus sound engineering service

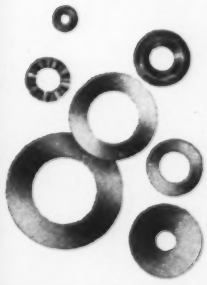
YOU CAN'T BEAT GARRETT!

SPRING LOCK WASHERS



Garrett Controlled Tension spring lock washers assure greater holding power, longer life of every assembly. Garrett makes a complete line of lock washers to ASA and SAE specifications, plus many special types . . . in all metals and plated to your requirements.

FLAT WASHERS



Garrett gives you fast delivery from stock on the largest line of flat washers available. Precision-made in thousands of different sizes and types—standards and specials. Also made to your exact specifications to meet the individual needs of your product.

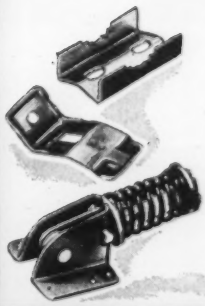
HOSE CLAMPS

AN 737 . . . stainless steel, radial type with floating bridge and thumb-screw adjustment. Approved for aircraft use.

QS-100 & AN-748 . . . worm-type, self-locking screw. Plated to prevent corrosion. Approved by Armed Forces.

AUTO-SEAL . . . screw-type adjustment, scarfed tongue prevents pinching. Staked bolt and captive nut. Rustproofed.

STAMPINGS



Quick deliveries on small and medium stampings made to your specifications on automatic, high-speed precision presses. Finishing equipment includes tumbling, polishing, heat treating and plating.

Manufactured by

MAIL THIS COUPON

Please send me without obligation complete data and technical details on Garrett parts.

NAME_____

COMPANY_____

ADDRESS_____

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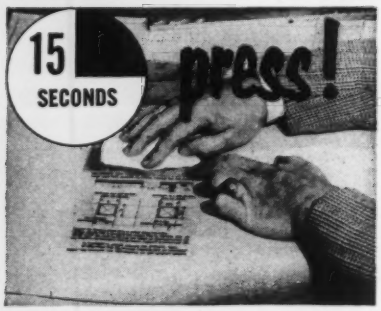
Garrett

OF PHILADELPHIA

GEORGE K. GARRETT COMPANY, INC. PHILA. 34, PA.



it's that simple!

Draftsmen want to use STANPAT in place of the old-fashioned time-consuming method of re-drawing and re-lettering specification and revision boxes, standard symbols, sub-assemblies, components, and cross sections.

STANPAT reprints your standard drawing details on acetate sheets with adhesive on front or back. Guaranteed not to dry out, come off, or wrinkle. Reproductions come crisp and clear. Save drafting time and money; use STANPAT whenever drawing details re-appear on your tracings.

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STANPAT CO., Whitestone 57, N. Y. U.S.A.
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☐ Please quote on enclosed samples
☐ Kindly send me STANPAT literature and samples

NAME _____
TITLE _____
COMPANY _____
ADDRESS _____

Circle 575 on page 19

Helpful Literature

speeds are 500 to 10,000 rpm, less gearhead. Gear ratios are 9.5 to 55,446:1. 4 pages. Barber-Colman Co., Aircraft Controls Div.

Circle 416 on page 19

Rotating Hydraulic Drives

Automation and its application in performing operations on continuous webs is topic of reprint 15011 entitled "Industrial Rotating Hydraulic Drives." Tension, speed, control, acceleration, deceleration, torque and synchronizing these drives are some of the problems covered by this bulletin. 8 pages. Oilgear Co.

Circle 417 on page 19

Large Nuts

Large hex, square and special nuts ranging in size from 1¾ to 8 in. are subject of buying manual for builders of large machines, presses and engines. Specifications and prices are given and the manufacturing processes used are described. 36 pages. Jos. Dyson & Sons, Inc.

Circle 418 on page 19

Flash Welding

Resistance flash welding of components for aircraft and similar applications is described in illustrated bulletin SP-15. Examples of various parts and assemblies are shown and advantages of the process are given. Taylor-Winfield Corp.

Circle 419 on page 19

Electric Heaters & Devices

General data and design selection charts on strip heaters; natural and forced convection air heaters; oven, immersion and cartridge heaters; melting pots; industrial hot plates; and heater control equipment are found in revised catalog 27-620. Specifications are given. 28 pages. Westinghouse Electric Corp.

Circle 420 on page 19

Quick-Locking Fasteners

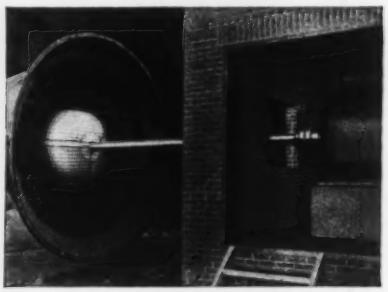
Fast opening and powerful locking of all types of covers, doors and panels are provided by Q-One fasteners which lock tight with a quarter turn. They are easily installed by welding, rivets or screws. Wide variety of types are detailed in illustrated booklet AF-1. 24 pages. Illinois Tool Works, Fastex Div.

Circle 421 on page 19

Metal & Plastic Gears

Fine and coarse pitch gears and sprockets of such materials as stainless steel, bronze, Bakelite, steel and nylon can be produced to order by this company. Spiral, helical, spur,

Eliminate Intermediate Bearings!



By using Thomas Flexible Couplings on long, unsupported shafts, intermediate bearings are eliminated. Thomas engineers tubular shafts free from lateral whip.

The large fan shown above is 16' from the motor to allow sufficient air intake. Miners working underground receive their fresh air supply from this fan and others like it, which have been giving dependable service for as long as fifteen years . . . without shutdowns for lubrication or maintenance of the couplings.

Thomas floating shaft flexible couplings are recommended for machine and marine drives, printing presses, paper and cement mills, cooling towers, diesel engines, pumps, compressors, and many other uses.

Only Thomas Flexible Couplings offer *all* these advantages

UNDER LOAD and MISALIGNMENT

1. Freedom from Backlash—Torsional Rigidity
2. Free End Float
3. Smooth Continuous Drive with Constant Rotational Velocity
4. Visual Inspection in Operation
5. Original Balance for Life . . . *and*

Thomas All Metal Couplings have No Wearing Parts so Lubrication and Maintenance are Eliminated

Write for Engineering Catalog 51A

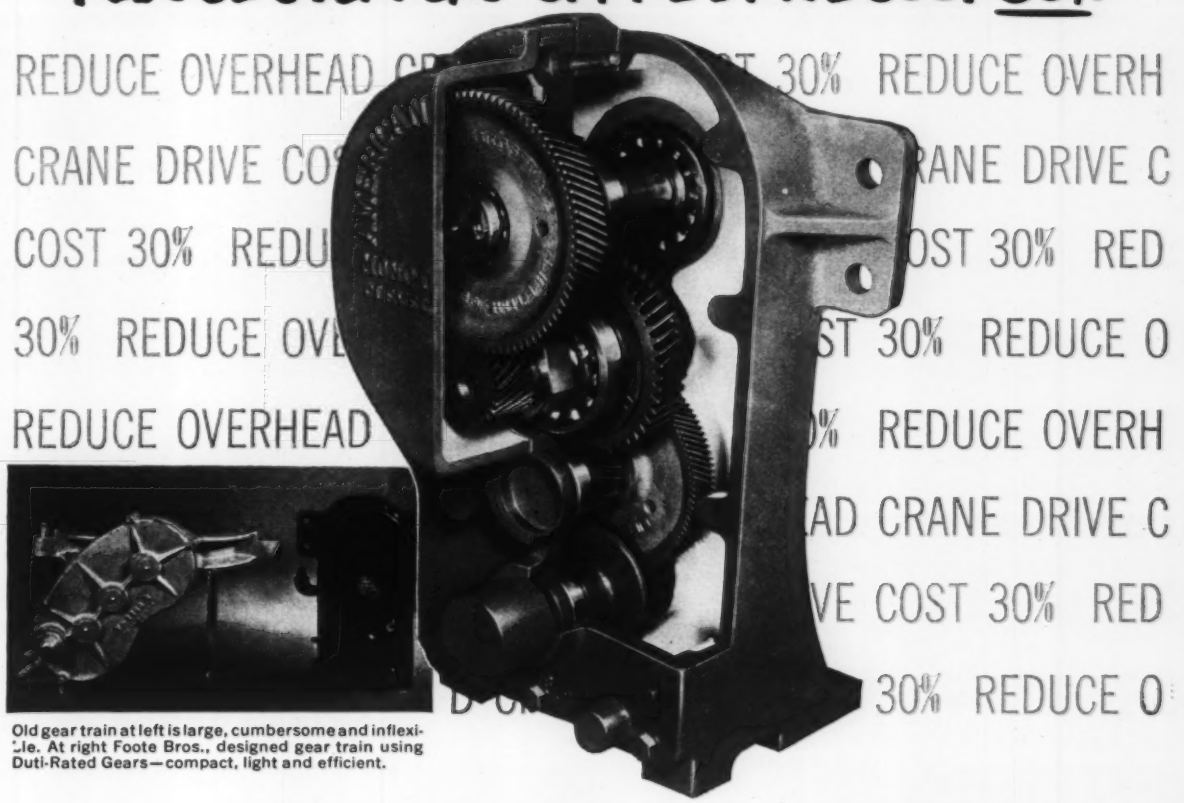
THOMAS FLEXIBLE COUPLING CO.

WARREN, PENNSYLVANIA, U.S.A.

Circle 576 on page 19

Duti-Rated Lifetime Gears

REDUCE OVERHEAD CRANE DRIVE COST 30%



Old gear train at left is large, cumbersome and inflexible. At right Foote Bros., designed gear train using Duti-Rated Gears—compact, light and efficient.

100% more capacity - 25% less weight - 28% less size

Ordinary commercial gearing in the traversing drive for an overhead, traveling crane system was bulky and had to be set at a space wasting 45° angle to save head room. Foote Bros. designed a special transmission system using Lifetime Duti-Rated Gears, permitting the application of smaller gears for the same capacity, allowing shorter center distances and a much more compactly designed drive.

The savings in space not only improved the design and performance of the overhead crane but also life expectancy. Maintenance requirements were greatly reduced. An outstanding feature of the new drive was that the Duti-Rated Gears could be interchanged on the same centers to change the ratios . . . allowing various speeds, fast and slow, for traversing.

This is only one example of what Duti-Rated Gears are doing in industry today. Extra gear capacity in less space . . . with longer life and lower costs . . . could be important to you, too. Call Foote Bros. today and learn all the advantages of Duti-Rated Lifetime Gearing . . . pre-engineered as standard or designed for your application. *FREE! Foote Bros. Engineering Manual "Duti-Rated Lifetime Gearing". Write for your copy today!*

This trademark stands for the finest industrial gearing made!

FOOTE BROS. Duti-Rated® LIFETIME GEARING

T.M. Reg. U.S. Pat. Off.

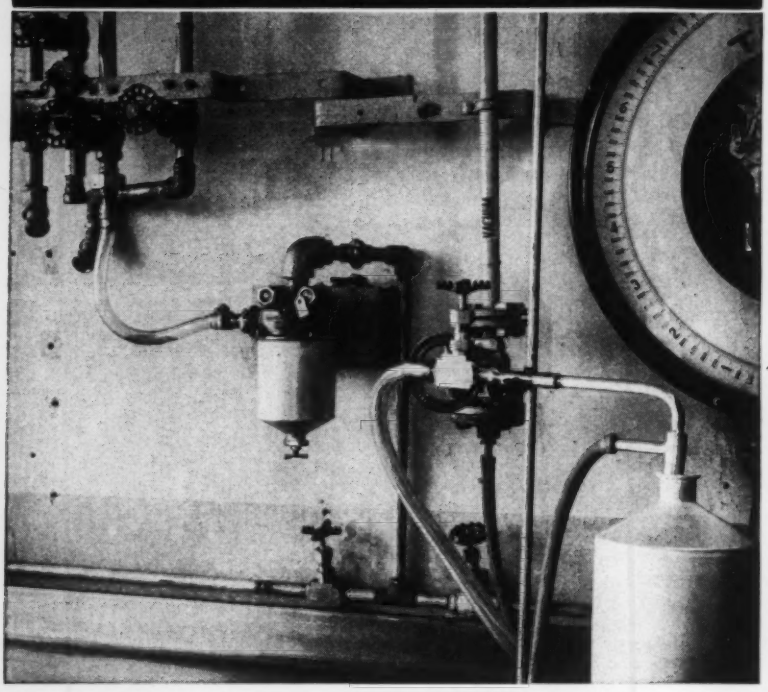
FOOTE BROS.

Better Power Transmission Through Better Gears

Foote Bros. Gear and Machine Corporation

4545 South Western Blvd., Dept. O, Chicago 9, Ill.

FILTER FORUM



Question:

"How do you filter a Vitamin Solution?"

A manufacturer of vitamins experienced considerable difficulty with filtration in one of his vitamin processes. The filter element used clogged after a mere 5 gallons of material had gone through. How could he eliminate frequent cleaning and maintenance and still achieve a clear, sparkling syrup?

Answer:

Ingenuity

Purolator recommended their PR-255-15 Aviation Fuel Filter. This unit is made of aluminum and contains a pleated paper Micronic® element. The filter has been extremely satisfactory. One cartridge filters 100 gallons before servicing . . . nearly 20 times more than the previous filter, with an even finer degree of filtration. Since the cartridge is of the disposable type, it is removed and replaced after each run, cutting time, handling and loss to a minimum. The excellent results of this application of a standard aviation type filter to a highly specialized operation demonstrates the advantages of Purolator's exceptional experience in solving filtration problems.

MAIL COUPON FOR DESIGN INFORMATION

PUROLATOR

FIRST in the field of filtering

Dept. D12-88 Purolator Products, Inc., 970 New Brunswick Ave., Rahway, N. J.

Please send me the following filter information:

_____ Purolator's new "Filtration Manual for Designers". I'm enclosing 25¢ to cover postage and handling.

_____ Enclosed is a description of our filter problem. How should we solve it?

NAME_____ TITLE_____

COMPANY_____ ADDRESS_____

CITY_____ ZONE_____ STATE_____

Circle 578 on page 19

Helpful Literature

internal and pinion types up to 6 in. diameter, plus many other gear types are shown in illustrated bulletin. 4 pages. Process Gear Co.

Circle 422 on page 19

Vibration Meter

Lightweight battery-operated type 1-128 vibration meter is described and illustrated in bulletin 1566. Transistorized unit has four ranges and its output signal may be viewed on an oscilloscope. 4 pages. Consolidated Electrodynamics Corp.

Circle 423 on page 19

Plastic Laminate Fabric

Properties of A-B-K laminated fabric which is impregnated with synthetic resins and compressed under heat adapt it as a solution to problems involving noise, impact, abrasion, excessive wear and lubrication. Material can be machined to close tolerances, formed under heat and pressure or bonded to metal. Physical properties of seven grades are tabulated. 6 pages. American Brake Shoe Co., American Brakeblok Div.

Circle 424 on page 19

Short Run Stampings

Facilities, personnel and experience for turning out "controlled tolerance" short run stampings are outlined in illustrated brochure No. 15. Large variety of metals and nonmetals are used in their manufacture. Ordering data are presented. 12 pages. Federal Tool & Mfg. Co.

Circle 425 on page 19

Magnetos

Super Spark magnetos for single and multi-cylinder engines are described in illustrated bulletin FM75F. Specifications of each type are given and types for specific engines are noted. 12 pages. Fairbanks, Morse & Co.

Circle 426 on page 19

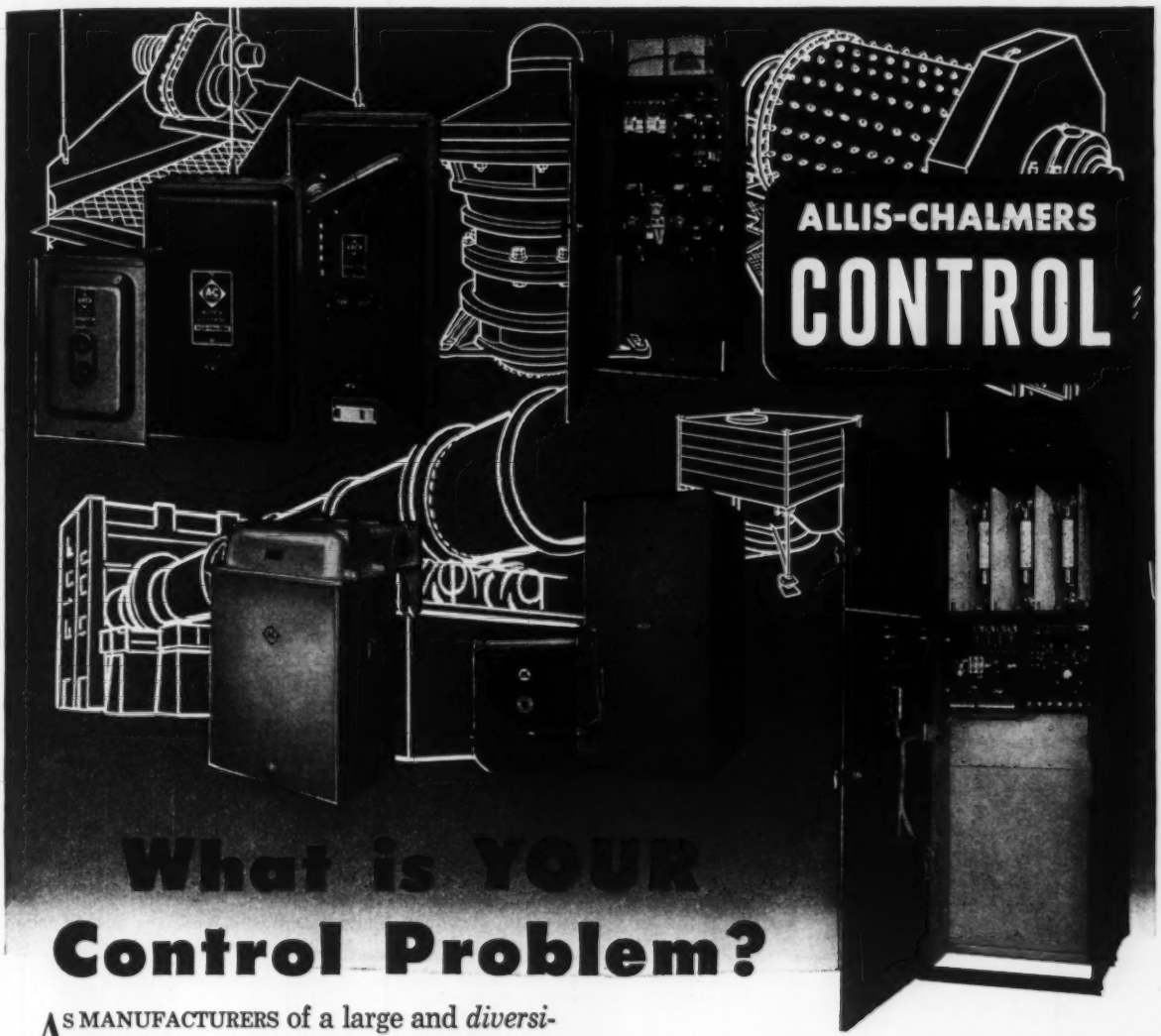
Quick-Dump Valves

Three-way quick-dump multipurpose valves for air, oil, water or Freon, described in illustrated form QD-556, install either normally open or normally closed. Operating details and descriptions of various models are given. 4 pages. General Gas Light Co., Humphrey Products Div.

Circle 427 on page 19

Clutches, Brakes, Etc.

Applications and design data on Fawick Airflex clutches, brakes, couplings, power takeoffs, Rotorseals, quick-release valves and high speed controls are given in illustrated bul-



What is YOUR Control Problem?

AS MANUFACTURERS of a large and *diversified* line of major industrial equipment, Allis-Chalmers has been called upon to solve thousands of control application problems in practically every industry. This specialized experience in coordinating power utilization is *yours* when you specify Allis-Chalmers control.

Control for every ac application

Allis-Chalmers offers an extensive line of manual and magnetic control to meet every condition of motor operation. Control functions, varying with specific job requirements, include full or reduced voltage starting, acceleration, speed control, reversing or non-reversing, and dynamic braking.

Custom protection

Built into all Allis-Chalmers control is the type and degree of protection dictated by the application. Controls are available in general purpose and special cabinet, including water-tight, dust-tight and explosion-proof enclosures.

A-4516

For complete information on any specific control problem, call your nearby Allis-Chalmers representative or write Allis-Chalmers, Milwaukee 1, Wis.

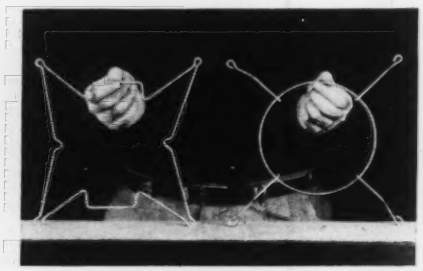
ALLIS-CHALMERS

"Simplicate it... and add more Lightness"

This famous saying by one of America's leading research engineers is the key to much of today's design progress. Sometimes all it takes is the right twist—in Wire. Here are a few specific examples from "Wire Goods Headquarters" . . .

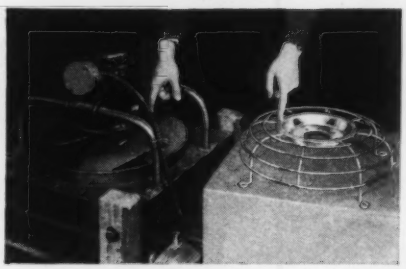
This simple twist saved $1,530.00 in one year

Manufacturer's wire motor mount design called for 26 bends in a 28"-long wire . . . almost impossible to hold tolerances. Titchener suggested simplified design at right: a ring, 4 support wires, 4 welds—that's all. Estimated saving 10.2c per piece.



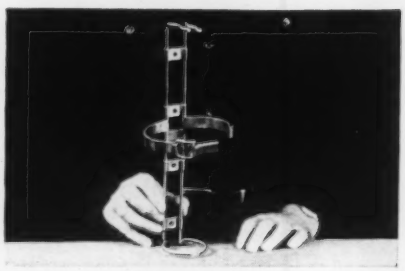
This simple twist saved 75¢ per unit

By combining a motor mount and fan guard in one wire-and-strip assembly, Titchener eliminated expensive pipe frame-work and heavy stampings, reduced noise level, and saved 75c per unit over the former design.



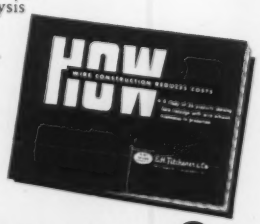
This simple twist cut weight in half

Extinguisher wall bracket redesigned by Titchener eliminates 16 rivets and 3 stampings. Improved design is stronger, more serviceable—weighs half as much—gives substantial savings in manufacturing and material costs.



Wire construction and design assistance by Titchener may be able to solve your cost problem, whatever your product. Our engineers will be glad to help you find out. Merely send prints or samples. No cost or obligation for our analysis and recommendations.

Free Case History Booklet. Shows before-and-after illustrations of 36 products and parts which have been redesigned in wire. Gives specific cost savings and product improvements accomplished. This booklet can be a storehouse of tips and ideas for design and purchasing men.



WIRE GOODS Headquarters

E.H. Titchener & Co.

61 Clinton St., Binghamton, N. Y.

Circle 580 on page 19

Helpful Literature

letin 500-A. Dimensions, torque ratings and selection and installation data are included. 36 pages. Fawick Corp., Fawick Airflex Div.

Circle 428 on page 19

Tool & Die Components

Handle balls, clamps, eye bolts, fixture locks, handles and knobs, hand wheels, safety pliers, set-up aids, vises and tool components are some of the die, jig and fixture parts that are described and priced in 1956 condensed catalog. All dimensions are given. 60 pages. Reid Tool Supply Co.

Circle 429 on page 19

Bolts & Screws

Illustrations of typical low carbon, high carbon, alloy and stainless steel cap and set screws; machine, aircraft, welding, carriage and miscellaneous bolts; and special screws in diameters from 5/16 to 5/8-in. are included in bulletin CA652. 4 pages. American Screw Products Co.

Circle 430 on page 19

Fluid Drives

Ratings of up to 50 hp at 1800 rpm with electric motor drives and up to 85 hp at 2600 rpm with engine drives are obtained with size 126 type T Gyrol fluid drives described in bulletin 9719. Drives absorb shock, facilitate low load starting and limit torque. 2 pages. American Blower Corp., Hydraulic Coupling Div.

Circle 431 on page 19

Air Control Valves

Two, three and four-way air control valves for high or low pressure applications are detailed in illustrated catalog. Available types include cam, flow control, foot, hand, interlocking, pilot, pressure regulator, quick exhaust, sequence, solenoid, time delay and booster. Also presented are single and double acting air and hydraulic cylinders and components. 72 pages. Airmatic Valve, Inc.

Circle 432 on page 19

Colloidal Dispersions

Forty-one colloidal and semicolloidal dispersions for operating functions, maintenance, lubrication, machine design and other industrial applications are listed in booklet, "A List of 'dag' Dispersions for Industry". Included are graphite, molybdenum disulfide, mica, vermiculite, zinc oxide and acetylene black dispersions. 4 pages. Acheson Colloids Co.

Circle 433 on page 19

IMPROVED AVIATION FASTENING

by Southco

Quick Release Feature Combined with High Strength-Weight Ratio

Superior Resistance to Vibration
Alignment Not Critical

Ideally suited for fastening hinged or completely removable panels, Lion Aircraft Fasteners are widely used by aircraft manufacturers where frequent access for inspection or maintenance is required.

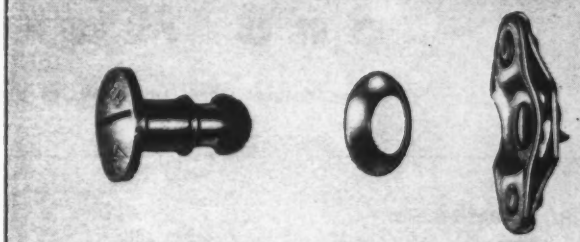
Locking and unlocking is accomplished without force in fractions of a second . . . one-quarter turn clockwise to lock tight . . . one-quarter turn counter-clockwise to unlock.

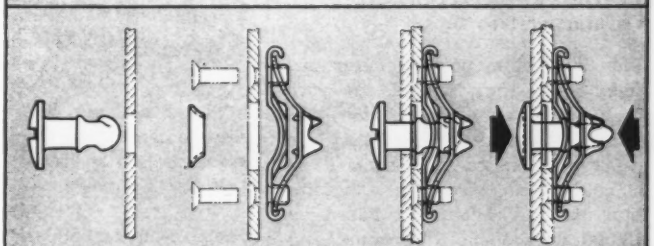
Lion Fasteners are safe, dependable, durable, economically installed, and provide long, trouble-free service.

Lion No. 5 Fasteners are available with flush head or oval head studs for screwdriver operation. Studs are also available with ring heads, wing heads, notched heads (for key operation), and knurled heads. Installation is simplified by a permissible float of .070 in all directions.

In addition to Lion No. 5 Fasteners, Lion No. H Fasteners are available for installation where extra high strength is required and Lion No. 2 Fasteners for application where strength is not an important factor.

LION No. 5 AVIATION FASTENER




Stud
Grommet
Spring Assembly
Fastener in Position Ready for Locking
Fastener Locked with a Quarter-Turn. Spring Loading Holds Panels in Compression

FULFILLS ALL REQUIREMENTS OF MILITARY SPECIFICATION MIL-F-5591A (ASG)

Locking torque, min.	5.0 lb. in.
Locking torque, max.	12.0 lb. in.
Unlocking torque, min.	5.0 lb. in.
Unlocking torque, max.	15.6 lb. in.
Initial tension, min.	35 lbs.
Rated tensile load	500 lbs.
Rated shear load	500 lbs.
Locking stop strength, min.	60 lb. in.

VIBRATION REQUIREMENTS

Frequency	3,600 CPM 100
Amplitude	1/16 in.
Load	175 lbs.
Endurance, min.	25,000 cycles
Lateral movement of Class A, Types I, II, and III Receptacle, min.	.062 in.

Lion Fasteners meet or exceed all of the specifications shown above.

Lion Catalog, containing complete specifications and installation procedure, sent free on request. Southco Div., South Chester Corporation, 237 Industrial Highway, Lester, Pa.

LION Aviation FASTENERS

SOUTHCO DIVISION LION

SOUTH CHESTER CORPORATION • LESTER, PENNSYLVANIA

BLIND RIVETS | SCREW FASTENERS | ADJ. PAWL FASTENERS | DOOR LATCHES | RETAINING SPRINGS | ANCHOR NUTS

SOUTHCO DIVISION
South Chester Corporation
237 Industrial Highway, Lester, Pa.

Please send me free Lion Catalog containing specifications and installation procedure.

NAME_____
COMPANY_____
ADDRESS_____
CITY_____ ZONE_____
STATE_____

Circle 581 on page 19

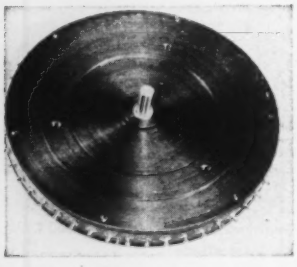
New Parts and Materials

Use Yellow Card, page 19, to obtain more information

Multitap Potentiometer

precision component has distortion-free taps

This 5-in. diam potentiometer has forty-eight taps spaced to give forty-seven equal resistance sections. Guaranteed linearity is ±0.1 per cent; total resistance is 500,000 ohms, affording a resolution of 0.0075 per cent based on 13,000 wire turns. Terminal and



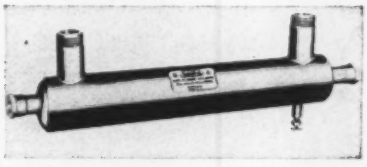
tap design of the RL-270A pot permits use of a large number of taps without adverse effect on potentiometer performance. Precious-metal spring contacts, with extremely high unit pressures, insure permanent, vibration-proof contact without linear distortion at the taps. Other models, with diameters from 5 in. down to 1¼ in., are available with from seventy-four to fourteen taps. **Gamewell Co.,** Precision Potentiometer Div., Newton Upper Falls 64, Mass.

Circle 451 on page 19

Oil Cooler

is compactly built, has high transfer rate

Construction of heat-transfer surfaces in this model WIO oil cooler gives more cooling in less space. Of nonferrous materials, cooler is suited for application on all types



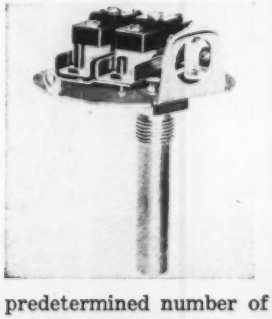
of diesel and gasoline engines, hydraulic equipment, air compressors, coolant systems and similar installations where a compact unit is required. Operating pressure range is up to 250 psi, and operating temperature range is up to 300 F. **Heat-X Inc.,** Brewster, N. Y.

Circle 452 on page 19

Heavy-Duty Thermostat

controls two separate circuits

Series 22000 dual-control Thermoswitch, incorporating a liquid-filled sensing element with a sensitive bellows and push rod assembly, actuates two precision miniature snap switches mounted in the head. Each switch controls a separate electrical circuit. Service temperature ranges can be specified as: −75 to 125 F; 25 to 225 F; and 100 to 300 F. As optional equipment, a differential setting arrangement can be adjusted to permit the second switch to operate

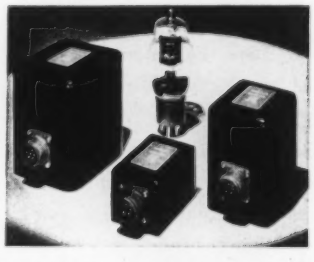


at a predetermined number of degrees above or below the setting of the first. Differentials between the switches can be specified from 0 F to 200 F. Contact ratings are up to 20 amp, 125 or 250 v ac; 10 amp at 125 v dc. Sensing bulb is ⅝-in. diam and approximately 3¾ in. long, furnished with either a flange mount or threaded fitting. **Fenwal Inc.,** Ashland, Mass.

Circle 453 on page 19

Subminiature Power Supplies

dc magnetic units have no vacuum tubes or transistors



Subminiature, highly - regulated magnetic-amplifier dc power supplies are available in sizes and ratings from 5 v, for strain gage and transducer operation, to 550 v for regulated plate-voltage supplies. Designed for reliability, units contain no vacuum tubes or transistors and are sufficiently rugged and stable for severe environmental applications, such as in missiles. **Arnoux Corp.,** Dept. MD-5, Box 34628, Los Angeles, Calif.

Circle 454 on page 19

Pushbutton Switches

in miniature and subminiature models

Button-Switch is an unusually small, completely enclosed pushbutton switch that can be supplied either for behind-panel or front-panel mounting. Contact arrange-

how would you seal it?

Answer: The "Gask-O-Seal" at right. When you have a static sealing design problem why not find out how Franklin C. Wolfe Company's free design service can be of assistance.

FRANKLIN C. WOLFE CO.

"Sealing design specialist"

Culver City, California

* patent 2,717,793

Milford Rivets

Made of every metal that can be cold-formed . . . in a wide variety of finishes and platings.

TUBULAR • SPLIT
CUTLERY • SPECIAL

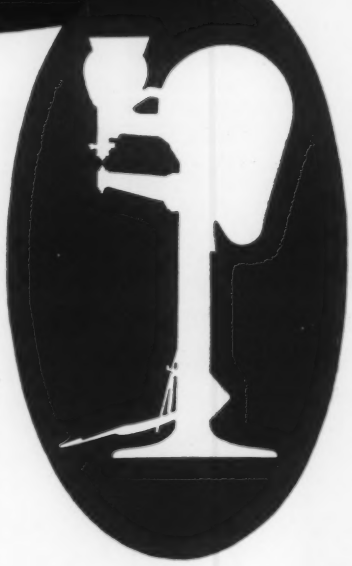
THREE FASTENER "MUSTS"

LOW COST • DESIGN FLEXIBILITY
AUTOMATIC ASSEMBLY

You get all three . . . and more . . . from Milford's five manufacturing plants.

Milford Rivet-Setting Machines

Bench or floor models, full or semi-automatic. Can be adapted to solve nearly every fastening and assembly problem.



WRITE FOR MORE DETAILED INFORMATION

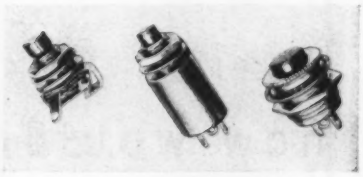
THE MILFORD RIVET

MILFORD RIVET & MACHINE CO.

MILFORD, CONNECTICUT • HATBORO, PENNSYLVANIA
ELYRIA, OHIO • AURORA, ILLINOIS • NORWALK, CALIF.

Circle 583 on page 19

New Parts



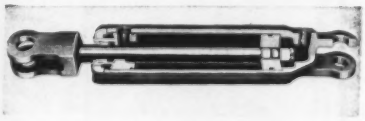
ments are single make-break and make-before-break. Button action is nonlocking; rating is 250 ma, noninductive ac, 30 w maximum. Subminiature Tini-Switch can be inserted through mounting panel without need for removing button. It is suitable for low-level circuits where low switch resistance is not an important factor. Action is single-make, single - break, or break-make. **Switchcraft Inc.,** 1328 N. Halsted St., Chicago 22, Ill.

Circle 455 on page 19

Hydraulic Cylinders

precision units have streamlined design

Heavy-duty, double and single-acting cylinders maintain accurate rod alignment by means of a patented gland positioned by a prestressed snap ring. Piston rods are heavy chrome plated; cylinders are honed, seamless steel tubing with welded cast-steel clevises. Aluminum-alloy pistons minimize



corrosion and scoring. Available in bore sizes from 2½ to 4 in., and in strokes from 1 in. through 18 in., cylinders are designed for operating pressures through 1500 psi. **Densmore Engineering Co. Inc.,** 235 E. Greenleaf St., Compton, Calif.

Circle 456 on page 19

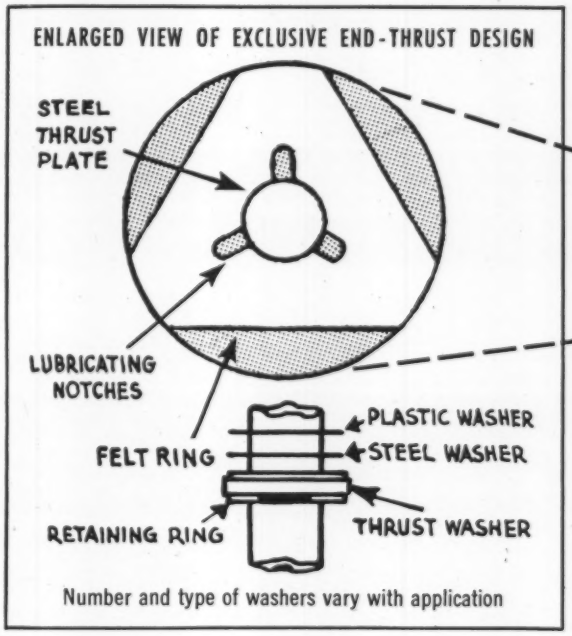
AC Motor-Tachometer

for integrating and rate servo systems

This 400 cycle ac motor-tachometer, designed for precision airborne integrating and rate servos, incorporates a tachometer and a four-pole servo motor. Tachometer linearity error over the 0 to

Emerson-Electric engineering highlights

New, exclusive end-thrust design for vertical and shaded-pole, sleeve-bearing motors



Number and type of washers vary with application

Reduces wear and end play—minimizes starting failures and burnouts

Smooth, quiet operation and longer motor life result from the exclusive end-thrust design incorporated in Emerson-Electric sleeve-bearing motors, for thrust applications.

The face of the new-design steel thrust plate is provided with three slotted lubricating notches. In operation, the lubricant-saturated felt ring "bellies" up through the slots. This causes the felt-ring lubricant to be carried to the thrust surface. Continuous lubrication is thus assured—longer, noiseless operating life results.

This exclusive end-thrust feature is another Emerson-Electric engineering highlight. It illustrates once more the reason why Emerson-Electric motors have been the wise choice for power-driven equipment for more than 60 years.

Call on Emerson-Electric motor-drive specialists

The combined experience of Emerson Electric motor-drive specialists is available to designers and manufacturers of motor-driven appliances. This valuable "assist" from Emerson Electric can be profitably applied, whether you're designing or redesigning for performance and sales. Write for Bulletin No. M-42, THE EMERSON ELECTRIC MFG. CO., St. Louis 21, Mo.

Emerson-Electric of St. Louis • Since 1890

BRANCHES: NEW YORK 7, N. Y., 11 Park Place • CHICAGO 23, ILL., 1623 S. Pulaski Road • SYRACUSE, N. Y., 209 Oakley Drive
PHILADELPHIA (Secane), PA., 868 Quince Lane • DETROIT 7, MICH., 1375 E. Jefferson Ave. • CLEVELAND 16, OHIO, 1580 Rockland Ave.
LOS ANGELES 42, CALIF., 5415 York Blvd. • DAVENPORT, IOWA, 617 Brady Street • CINCINNATI 11, OHIO, 2917 Ratterman Ave.

CASE HISTORY 1

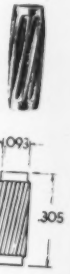
REQUIRED:
A dependable supply of this small, machined electrode to meet customer's quality and quantity needs at reduced cost.

HASSALL SOLUTION:
Hassall-designed re-heading process, involving no critical dimension changes, resulted in a 59% cost reduction to customer.

CASE HISTORY 36

REQUIRED:
Less costly manufacturing method for this small stainless steel fluted pin which cost $19.20 per M as a screw machine product.

HASSALL SOLUTION:
Cold forming by Hassall at a cost of $2.95 per M gave the customer an 85% cost reduction on this part.



SPECIALTY MANUFACTURER OFFERS SAVINGS ON SMALL PARTS AND FASTENERS

CASE HISTORY 89

REQUIRED:
Customer looking for low cost, high production rate method of producing mandrels for rotary dental brushes.

HASSALL SOLUTION:
Hassall-originated design for cold-heading replaced chamfered end with tumbled, round end; maintained rigid specifications for straightness and made low-cost production possible.

Multiply these case histories a thousandfold and you'll get some idea of the variety of tough problems we crack, and the savings we effect for our customers in the course of a year.

Our cold-heading process—supplemented by secondary operations—imposes amazingly few limitations on the parts and fasteners we can make. Don't forget that we are not limited to "stock" sizes. These illustrations show that Hassall—a specialty supplier—can show you substantial savings, better deliveries and technical assistance on your small parts and fasteners.

Proof? Send us your specifications or write for catalog.

John Hassall, Inc., P. O. Box 2197 Westbury, Long Island, New York.

CASE HISTORY 37

REQUIRED:
Bumper bolt with bonded rubber cap for license plate support.

HASSALL SOLUTION:
The large head on this bolt would ordinarily call for screw machining but the two lugs under the head ruled this out. Progressive cold-heading was Hassall's answer.

HASSALL

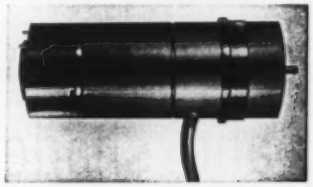
SINCE 1850

NAILS, RIVETS, SCREWS AND OTHER COLD-HEADED FASTENERS AND SPECIALTIES

Circle 585 on page 19

New Parts

4000 rpm range is 0.05 per cent; scale error is 0.05 per cent for a −55 to 75 C temperature range; the 400-cycle null voltage is reduced to less than 1 mv in phase and quadrature. Output voltage



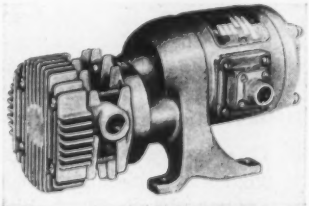
at 3600 rpm is 3.6 v within 0.05 per cent. A built-in heater and temperature-sensitive winding are connected to a magnetic amplifier external to the tachometer. No-load speed of the servo motor is 9500 rpm, stalled torque is 0.9 oz-in. and input is 7w per phase. The unit is flange mounted and measures 1.437 in. diam by 4¼ in. long. **Precision Components Inc.,** 65 Rushmore St., Westbury, L. I., N. Y.

Circle 457 on page 19

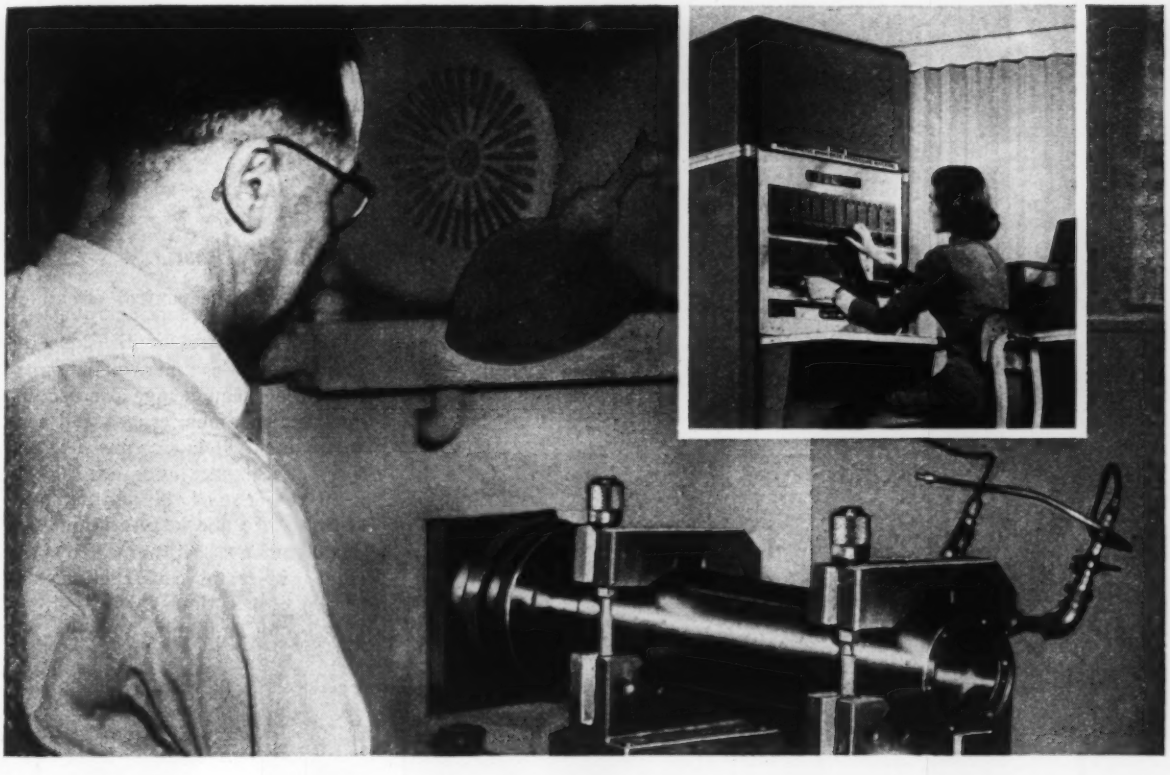
Air Pump

rotary-vane unit delivers oil-free air

For supplying oil-free air to electronic installations in aircraft, as well as other aircraft or missile applications, model RG-10090-C electric motor driven air pump is a positive-displacement, rotary-vane type delivering 0.8008 cu in. displacement per revolution. Pump blades are self-lubricating, and no seals or shaft packing are used. Rated capacity is 700 cu in. per min at 68 F, 9-in. Hg ab-



solute inlet pressure and 34-in. Hg absolute discharge pressure. Check valve built into outlet port of pump permits intermittent operation without loss of system pressure through pump. Motor is rated at 0.333 hp at 4800 rpm, 115 v, 400 cycle, 3 phase ac. Weight



ELECTRONIC COMPUTER

Gets An Assist From B&W Mechanical Tubing

A remarkable "think" machine—called the Type 650 IBM Magnetic Drum Data Processing Machine—is designed to serve the large areas of computation not now covered by the huge "brains" or the smaller electronic calculators. A product of International Business Machines Corp., this commercial and engineering computor can "think", "remember" and store information, and is capable of simultaneous computation and calculation.

As its name implies, a vital part of this unique machine is the rotor shell of the Magnetic Drum which provides the information storage space on the drum. To produce this shell with its required magnetic property, high quality B&W Mechanical Tubing is cut to size, turned, ground, copper-plated, then coated with a nickel-cobalt special magnetic-field plating and finally dynamically balanced.

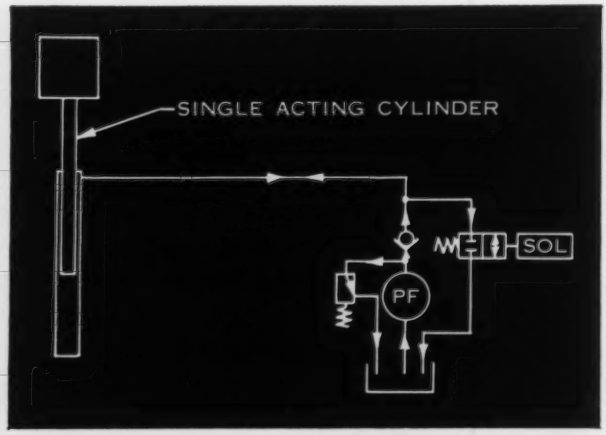
In a precision machine such as this, the selection of B&W Mechanical Tubing depended upon its ability to meet not only specific fabrication requirements but also a number of unusual service conditions. For example, the drum rotor turns at high speed and must retain its stability. In addition, temperatures and vibrations can also directly affect its function in the machine.

The highly satisfactory performance of B&W Mechanical Tubing in this uncommon application is typical of its performance in *all* types of products and services with *all* kinds of requirements. Write for Bulletin 361 for the comprehensive story of how B&W Mechanical Tubing serves Industry. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pa.

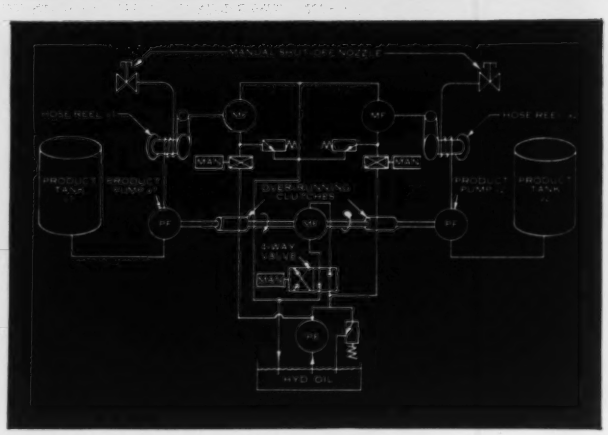
TA-6005 (M)

Seamless and welded tubular products, seamless welding fittings and flanges—in carbon, alloy and stainless steels

SIMPLE CIRCUIT



COMPLEX CIRCUIT



ROPER
Serves Both Best

The key to any hydraulic system is the pump. It must have the proper characteristics in relation to the other equipment in the circuit — whether simple or complex. It must also be *dependable* and have the *stamina* to provide long and trouble-free service. Roper Rotary Pumps *have* the attributes that are so necessary to effect optimum performance, and you can count on them for successful control of circuits involving either tons or pounds. On your next hydraulic problem, investigate Roper Rotary Pumps Find out how they can be the key to a dependable hydraulic system

PUMPS TO 1000 P.S.I.

•

HYDRAULIC PUMP-MOTORS

High Torque Low Speed
Up to 11.5 H.P. output

SEND FOR CATALOG 936 AND SPECIAL BULLETIN 22

GEO. D. ROPER CORPORATION
248 Blackhawk Park Avenue
Rockford, Illinois

ROPER
Rotary Pumps

Circle 587 on page 19

New Parts

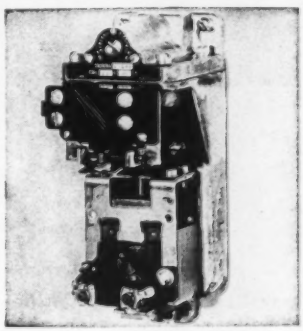
is 6.437 lb, and unit is rated for continuous duty at 20,000 ft altitude. **Lear Inc.,** Lear-Romec Div., Elyria, O.

Circle 458 on page 19

Pneumatic Timer

for automatic control circuits

Automatic control applications for this pneumatic timer include machine-tool sequencing, process industry operations, cranes and conveyor lines. It has a time delay of 1/5 to 180 sec, and accuracy is ±10 per cent of the setting. Resistance to shock, vibration and misalignment is provided by the rigid cast frame construction. Materials of the timer have been selected to minimize effects of



changes in humidity and atmospheric pressure, and a filtered vertical air intake prevents dust from entering the orifice. Operation of the timer is changed from on-delay to off-delay by means of a screwdriver. Units can be supplied with a maximum of two instantaneous interlocks, and NEMA enclosures are optional. **General Electric Co.,** General Purpose Control Dept., 1 River Rd., Schenectady 5, N. Y.

Circle 459 on page 19

Valve

ensures press and shear operator safety

Two-hand safety for operators of presses, brakes, shears and similar machines is provided by this non-tie-down valve, which is interposed between two palm-button

How to Solve a Tricky Temperature Problem

No. 7 of a Series — *Showing the broad application range of Fenwal Controls*

Temperature in a hair dryer is important. Too little heat and hair does not dry properly. Too much heat, and hair may be damaged. Rayette, Inc., St. Paul, Minnesota solved these problems in their Rayette Decor Hair Dryer with a Fenwal THERMOSWITCH® unit — *and obtained an important selling feature.*

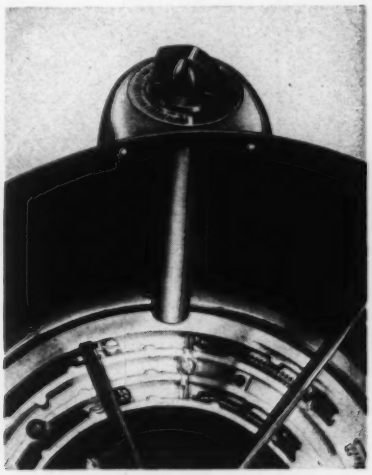
A Fenwal type 17200 block heat THERMOSWITCH unit is used. The unit is factory pre-set at the desired 70°F, and opens on temperature rise and closes when temperature falls to its set point. This gives Rayette their exclusive TEMP-control feature.

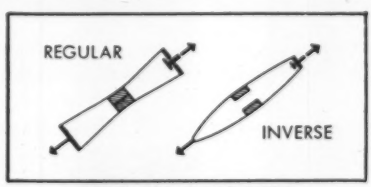
With the Fenwal THERMOSWITCH unit, the Rayette Decor Hair Dryer gives faster, more even drying and eliminates wet spots.

How Fenwal Thermoswitch Units Operate

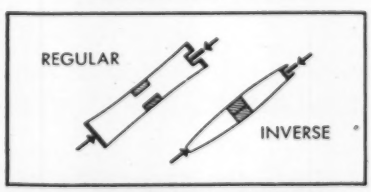
In THERMOSWITCH thermostats the activating *control* element is the metal shell which encases the contact elements. Changes in temperature cause the shell to expand or contract instantaneously. It is this feature that gives the Rayette Decor Hair Dryer its great precision. The change in temperature exerts tension on the struts, causing the contacts to make or break a circuit. Control in the Fenwal THERMOSWITCH units is calibrated at a given shell temperature by turning the adjusting screw until contacts operate.

THE RAYETTE DECOR HAIR DRYER shown above utilizes a Fenwal type 17200 block head THERMOSWITCH® unit in its exclusive TEMP-control feature.

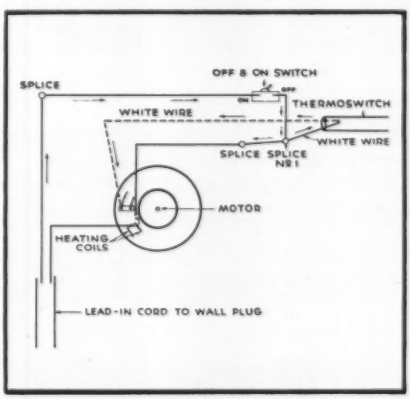




TENSION OPERATED



COMPRESSION OPERATED



Send Your Temperature Problem to Fenwal

Fenwal Sales Representatives and Engineers have saved time, trouble and money in all types of products, plants and laboratories by solving thousands of temperature control and detection problems. Fenwal THERMOSWITCH units are controlling processes that involve liquids, gases and solids.

Put Fenwal's vast reservoir of technical know-how to work for you. Chances are your problem has already been met and mastered by Fenwal engineers.

Write for new literature for details and complete product listings on Fenwal Thermoswitch Thermal Controls.

FENWAL INCORPORATED
198 Pleasant Street
Ashland, Mass.

Please send me your catalog MC-135.

Our specific problem is:.....

.....

.....

Name.....*Title*.....

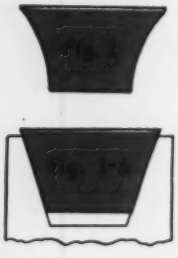
Address.....

City.....*Zone*. .*State*.....

Fenwal CONTROLS TEMPERATURES . . . *PRECISELY*

Circle 588 on page 19

Concave sides make V-belts last longer



The sides of every Gates V-belt (Fig. 1) are concave—a precisely engineered curve that greatly increases V-belt life. Here's why:

On the bend around the sheave, the concave sides of a Gates V-belt fill out and become straight (Fig. 1-A). Thus the belt makes full contact with the sides of the sheave, grips the sheave evenly, and wear is distributed evenly across the sides of the belt. Uniform wear lengthens belt life; keeps costs down.

Make this simple test

Take a straight-sided belt (Fig. 2) and bend it. Feel the sides at the bend; they bulge out. Now picture this bulge in the sheave groove (Fig. 2-A). It is easy to see that the belt makes uneven contact at points indicated by arrows. Naturally, wear is greater at these points. Uneven wear shortens belt life; increases belt costs.

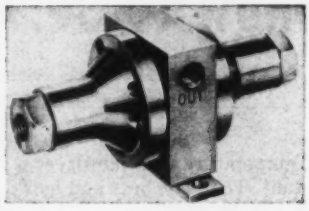
Cut down-time and V-belt replacement costs. Specify belts that grip evenly and wear longer . . . specify Gates Vulco Rope—the V-belt with concave sides. There is a Gates distributor nearby who will quickly supply the belts you need. The Gates Rubber Co., Denver, Colorado
—*World's Largest Maker of V-Belts*

TPA 88

Gates VULCO ROPE Drives

Circle 589 on page 19

New Parts



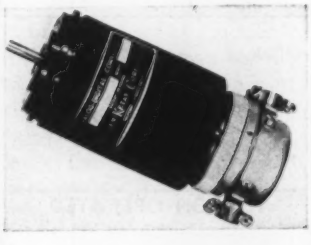
three-way valves in parallel and the receiver that is alternately pressurized and exhausted. If the machine operator engages or disengages only one of the palm-button valves, the valve automatically cuts off any subsequent air flow through itself to the receiver. Valve can be recocked only by releasing the engaged pilot valve. Tamper-proof integral adjustment is provided to permit reasonable delay between engagements of the palm button valves. **Ross Operating Valve Co.,** 120 E. Golden Gate Ave., Detroit 3, Mich.

Circle 460 on page 19

Analog-Digital Converter

counts 500-million times before service is required

For digitalizing pressure, thrust, temperature, position, etc., this analog-to-digital converter translates analog mechanical information into a natural binary code in parallel form on thirteen terminals. Complement of the output is simultaneously available on thirteen additional terminals. Total count of



8192 is provided in sixty-four revolutions of the input shaft. Accuracy is better than the output resolution, which is one part in 8192, or ± 0.012 per cent; input shaft resolution is one part in 128, or 2.8 deg. Natural binary output is unambiguous. Increasing count is available in either direction. Conservatively, 4-million revolutions, or better than 500-million

Parts Like These...at Big Savings

By FLO-FORM

How can FLO-FORM* parts save you money? Simple! By forming the part, hot or cold, out of bar or wire with practically no waste of costly metal.

Harper engineers have been specializing in parts of corrosion-resistant metals since the company was founded. With this background of experience they have been able to show manufacturers new tricks in producing parts of non-ferrous metal and stainless steel that have resulted in improved quality...reduced costs.

A new book containing examples of how other manufacturers have cut costs and other valuable information is now on the press. Reserve your copy by mailing the coupon.

BY THE WAY

If you use bolts, nuts, screws, washers, rivets of brass, bronze, Monel, aluminum or stainless steel, you probably know Harper's leadership in this field. Over 7000 different items are available from stock. Phone your Harper Branch or Distributor.

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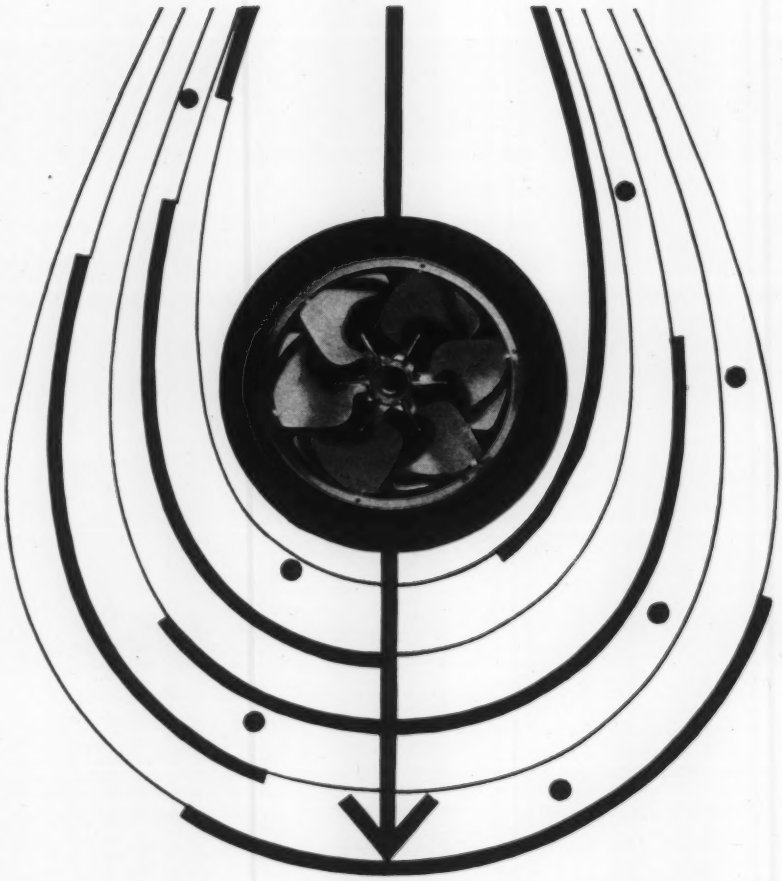
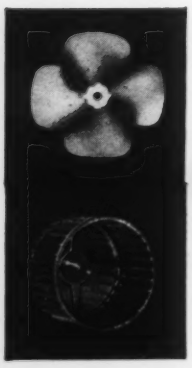
Torrington's nation-wide service to industry is channeled through one of the finest organizations of sales representatives in the world. With offices strategically located in 27 major metropolitan and industrial areas and Canada, this network of communications, service and distribution is part of the efficiency that has made Torrington the top name in the air-impeller field. Call us. We're just around the corner!





THE
TORRINGTON
MANUFACTURING COMPANY
TORRINGTON, CONNECTICUT
VAN NUYS, CALIFORNIA · OAKVILLE, ONTARIO

Circle 591 on page 19

TORRINGTON
AIR IMPELLER
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Chicago 11, Illinois

Marvin A. Heeren
1409 - 15th Street
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Gerald L. Lockwood
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T. G. Perry
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Wichita, Kansas

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St. Matthews Branch
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Cliff D. Watson
264 Wynnewood Village
Dallas 24, Texas

Merrill N. Musgrave & Company
2019 Third Avenue
Seattle 1, Washington

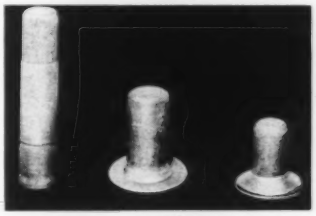
W. T. Brand
215 Hutton Building
Spokane 9, Washington

counts at 200 rpm can be expected before service on the unit is required. **Norden-Ketay Corp.**, 99 Park Ave., New York, N. Y.

Circle 461 on page 19

Fluid-Tight Rivets

seal against fluid or air leaks



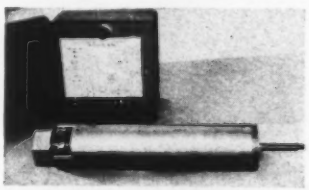
Intended for use in integral fuel tanks, external tanks, pressurized aircraft sections, or similar structures where loss of fluid or pressure is critical, these rivet fasteners seal themselves against fluid or air leaks without caulking or rubber sealing agents. Leakproof seal is given by a soft aluminum jacket which flows when the rivet is expanded after driving. Also available is a washered-head rivet designed for use where sealing is required under head of the rivet only, or where sealing compounds are applied between attached skin members. Double-shear stress values are 30,000 psi. Rivets are suited for use with automatic drilling and riveting machines and with hand-operated tools. **Pastushin Aviation Corp.**, 5651 W. Century Blvd., Los Angeles 45, Calif.

Circle 462 on page 19

Submersible Pump Motor

epoxy-sealed stator is gasoline cooled

Designed to overcome vapor-lock



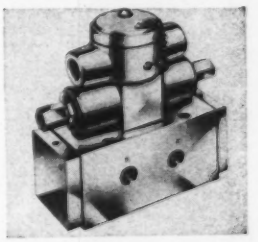
problems associated with suction pumping systems, this submersible pump motor is suited for use with high-octane volatile fuels, in warm areas, or at high altitudes. It installs in existing gasoline storage tanks with 3½-in. pipe flanges without adapters, and may be removed without disassembly. Stator is sealed in an epoxy resin, allowing gasoline to flow between stator and rotor for cooling, and within motor for lubrication. Rating is ¾-hp, 3450 rpm, 60 cycles, 230 v. Remote control box includes overload, starting, and control circuits. Motor is explosion-proof and is listed by Underwriters' Laboratory for Class I, Group D conditions. **Leland Electric Co.**, Div. of American Machine and Foundry Co., 1501 Webster St., Dayton 1, O.

Circle 463 on page 19

Air Valves

have full valve-port size flow passages

Series of solenoid and master air valves, available in five sizes from ¼ to 1 in., is used for controlling air cylinders and other air-operat-



ed devices. No restriction to air flow is introduced by the valve, the internal passages being of full valve-port size. Bubble-tight aluminum spool, which is sealed by O-rings, operates without metal-to-metal contact. Wearing parts are easily replaced without possibility of incorrect reassembly. Coils meet UL standards. **Hanna Engineering Works**, 1765 Elston Ave., Chicago 22, Ill.

Circle 464 on page 19

Miniature Resistor

power-type unit is rated at 3 w

Miniature 3-watt power-type resistors, trade named AXIOHM, are designed specifically for printed circuits and advanced miniaturiza-

(*Continued on Page* 184)

REPUBLIC

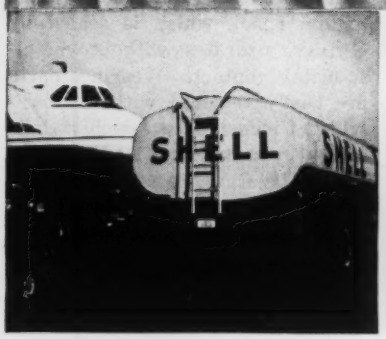
to help you push back

Republic—world's largest producer of aircraft steels—is ready to help you in two ways. First, with the materials needed to combat heat as well as strength-to-weight and corrosion problems. And second, with metallurgical service backed by over a quarter century of experience gained through helping hundreds of designers and manufacturers in all types of industries meet and solve similar problems.

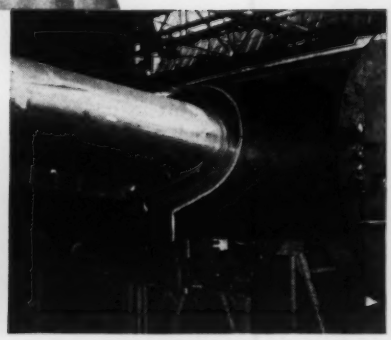
To date two materials, titanium alloys and stainless steels, best qualify to meet the severe service requirements for skin of aircraft and missiles flying at supersonic speeds.

Republic melts and rolls titanium in all forms—forging billets hot rolled and cold finished bars, plate, sheet and strip.

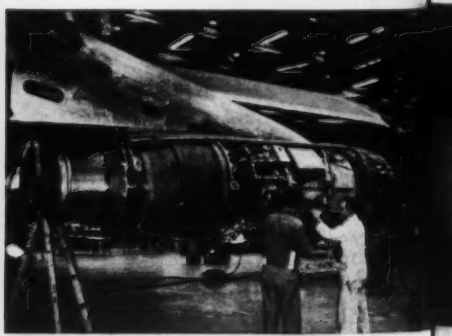
REPUBLIC STEEL



NEW DEVELOPMENTS create new uses. A unique tank truck with one compartment made of ENDURO Stainless Steel safely handles a corrosive alcohol-water mixture used in turboprop engines. Another compartment, for kerosene, is fabricated from Republic High Strength Steel for extra strength without added weight.



WEIGHT—On the DC-7 superliner, a weight saving, equivalent to one passenger and his luggage, resulted when Titanium replaced other materials normally used in nacelle construction. And with no sacrifice in strength or safety. Titanium offers the highest strength-to-weight ratio of construction metals.



SOLVING HEAT PROBLEMS is old stuff for ENDURO Stainless Steel. ENDURO's ability to withstand heat without loss of strength has been proved on jet engines where it is used for structural and burner components, rings, exhaust systems, afterburners. Now it is being used for skin material to resist high temperatures at supersonic speeds.

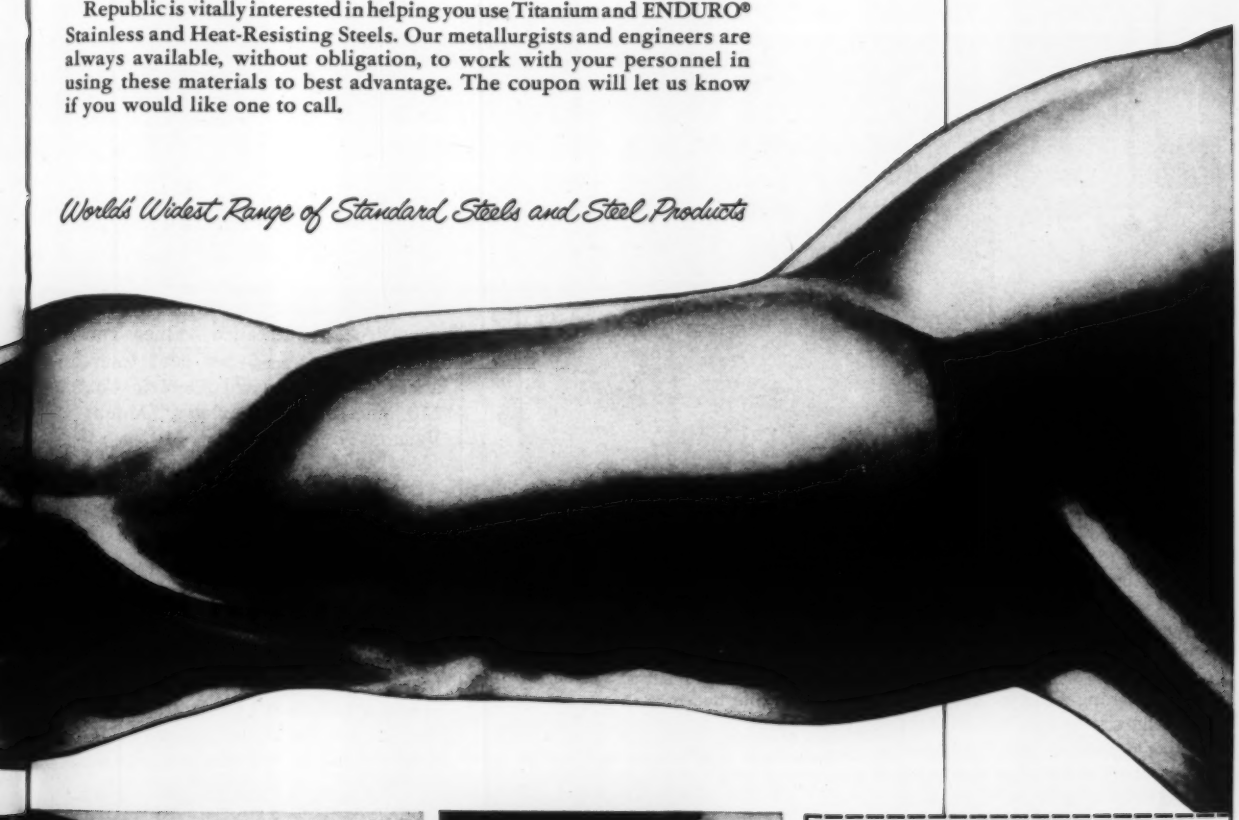
STEEL IS READY
the thermal barrier

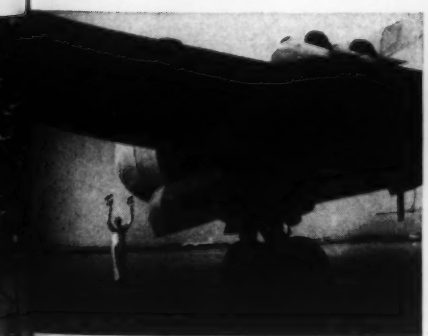
Republic is the world's largest producer of alloy, stainless and heat-resisting steels.

New developments in the fields of supersonic aircraft and missiles increase demand for aircraft quality steels. Republic is keeping pace. New facilities for increasing stainless steel cold rolling and finishing capacity have recently been added. Titanium facilities are being constantly improved and expanded.

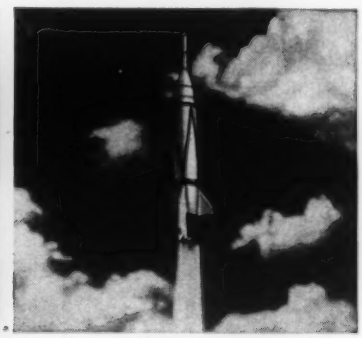
Republic is vitally interested in helping you use Titanium and ENDURO® Stainless and Heat-Resisting Steels. Our metallurgists and engineers are always available, without obligation, to work with your personnel in using these materials to best advantage. The coupon will let us know if you would like one to call.

World's Widest Range of Standard Steels and Steel Products





STRENGTH—Landing gear fabricated from Republic Alloy Steels can take the tremendous strain when aircraft hit the runway at high speeds. These fine steels provide the high strength and toughness needed to withstand high impact and heavy loads—provide the hardenability to resist wear at bearing surfaces.



CORROSION-RESISTANCE—Titanium's extremely high corrosion-resistant properties make it attractive for many applications, such as tanks for acids used in combination with missile fuels. Nitric acid has negligible effect on Titanium. It is practically immune to salt water and sea air corrosion.

REPUBLIC STEEL CORPORATION
Dept. C-2244
3130 East 45th Street
Cleveland 27, Ohio

Send more information on these Republic products.

- ☐ ENDURO Stainless Steel
- ☐ High Strength Steel
- ☐ Alloy Steel
- ☐ Titanium
- ☐ Have a metallurgist call.

Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____

Circle 592 on page 19

XUM

BUILD YOUR BUSINESS ALONG THESE LINES

with BIJUR Automatic Lubrication

By incorporating the Bijur System into your designs, you can offer substantial operating economies which progressive users now demand. For example, in the metalworking field 75% of machinery users prefer "built-in" automatic lubrication on the machines they buy.

Costly hand lubrication is eliminated.

Production time is saved because machines are oiled while in operation.

Bijur Automatic Lubrication is the best friend a bearing ever had. Every bearing is automatically fed a metered shot of oil at predetermined intervals.

Inaccessible bearings that require regular lubrication are never neglected.

There can be no problem of work spoilage or bearing headaches caused by over lubrication.

Leading machine builders have standardized on Bijur for a quarter of a century. Bijur puts the accent on engineering design – to satisfy the specific requirements of your machines.

Our engineers can show you how to build increased dependability into your machines, whether they are in production or still on the board.

Write for literature and engineering data.

2370

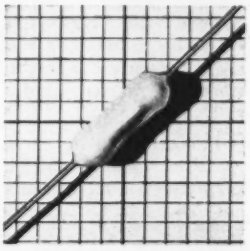
BIJUR
LUBRICATING CORPORATION
Rochelle Park, New Jersey
Pioneers in Automatic Lubrication

Circle 593 on page 19

New Parts

(*Continued from Page* 181)

tion designs where stability and overload capacity of wire-wound resistors are essential. Special alloy resistance wire, with low temperature coefficient of resistivity, is wound on miniature ceramic



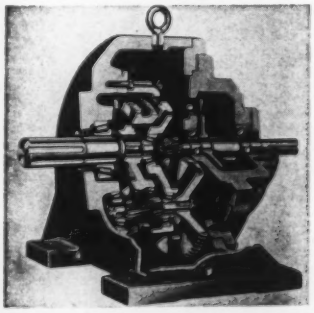
cores and encased in Vitrohm enamel to form a hard, crazeless, heat-conducting hermetic seal. Stock type 3X units are rated conservatively at three watts based on 300 C rise, 40 C ambient temperatures. Resistance values run to 6500 ohms, ±5 per cent tolerance. **Ward Leonard Electric Co.**, 115 MacQuestion Parkway, Mount Vernon, N. Y.

Circle 465 on page 19

In-line Speed Reducers

stock units available from one to 110-hp capacity

In-line helical speed reducers, developed for installations where mounting flexibility is important, are stocked in 18 sizes in single, double, and triple reductions. Design incorporates crown-shaved induction-hardened gearing, large



overhung capacity, and positive oil-bath lubrication. Backstops can be furnished with reducer, or installed in field without machining. Conforming to AGMA specifications, units are available in

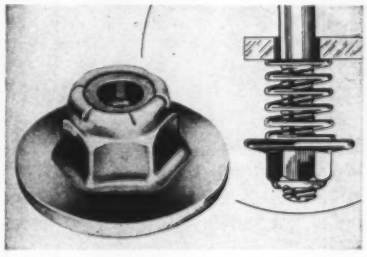
ratios from 1.25:1 to 205:1 and horsepower capacities from 1 to 110. Capable of mounting in virtually any position, the units may be direct-coupled, or chain or belt-driven on either or both shafts. **Philadelphia Gear Works,** G St. below Erie Ave., Philadelphia 34, Pa.

Circle 466 on page 19

Self-Locking Nut

has integral flange

Flanged hexagon self-locking nut has a large washer-type seat for applications involving spring tension, such as compressor motor mountings. Large, integral bearing area of the ESNA Type 1994 nut eliminates need of separate washer. During shipment of a spring-mounted assembly, nut is turned down to compress spring, forming solid mounting to resist



damage by shifting. Upon delivery, nut is backed off to proper spring tension to float unit; fiber locking insert retains selected position regardless of spring pressure or vibration. Nuts are steel, and are available plain or with plated finish. **Elastic Stop Nut Corp. of America,** 2330 Vauxhall Rd., Union, N. J.

Circle 467 on page 19

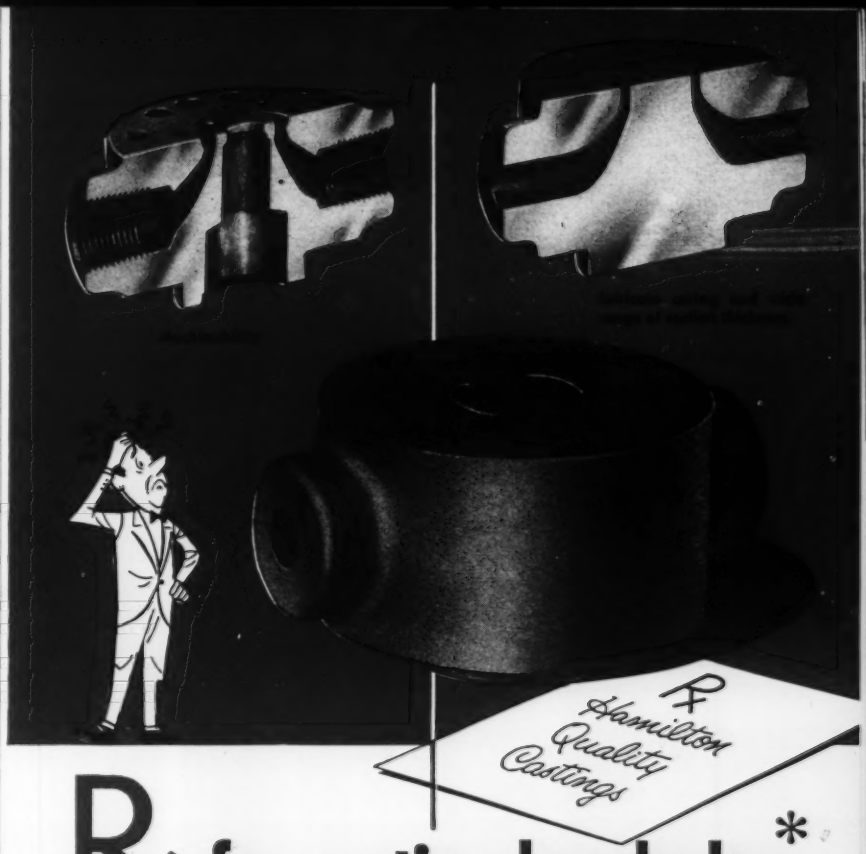
Ceramic Clutch Linings

have great heat and wear resistance

Clutch plates with ceramic-type linings, rather than conventional organic facings, offer high heat and wear resistance. The ceramic material, consisting of a compound of heat-stable ceramic and metallic ingredients, is compressed into shallow metal cups, forming disks. Six disks are used on each side of

(*Continued on Page* 188)

Circle 594 on page 19→



℞ for casting headaches*

Finding the proper castings often causes headaches for the purchasing, production and design men. Many have found the remedy in HAMILTON QUALITY CASTINGS.®

There are differences between foundries, and the differences can be important to you. Hamilton Foundry excels in the problem jobs . . . in castings that are hard to make because of intricate coring, thin metal sections, tight dimensional tolerances or high physical specifications. We take these jobs and consistently "make them right" . . . on time.

Our specialties are light and medium castings in Gray Iron, Alloyed Iron, Meehanite, Ni-Resist and Ni-Hard.

Why not let us relieve your casting headaches?

A 'phone call or letter will bring prompt assistance. Better still, send us the drawing with casting weight and a description of the pattern equipment. We'll be glad to prescribe for that "casting headache"

P.S. The above "headache casting", a pump body, was made in Meehanite; casting weight 3.87 lbs. Cored passages and sections ranging from 11/32" to 2 1/16" made this casting a tough one.

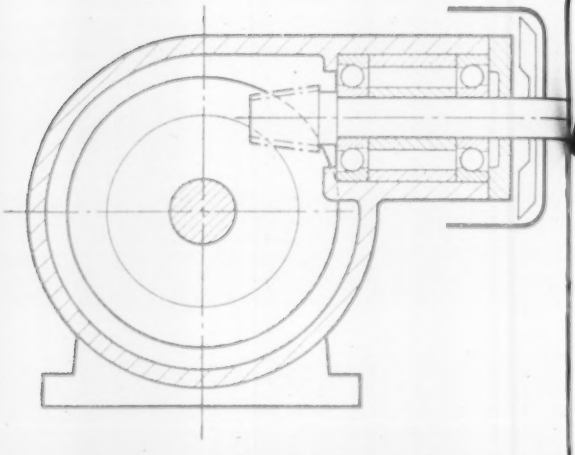
GRAY IRON • ALLOYED IRON
MEEHANITE • NI-RESIST • NI-HARD

THE HAMILTON FOUNDRY
AND MACHINE CO.
1551 Lincoln Avenue • Hamilton, Ohio
Phone TWinbrook 5-7491

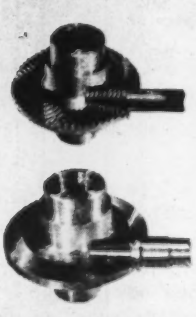
XUM

Why are Spiroid Gears so successful where compactness is vital? Spiroid Gears pack more power transmission capacity per inch diameter than worm gears. Spiroid Gears are smaller, stronger, more shock resistant and more efficient . . . giving you increased gear economy, greater gear versatility, high product performance standards!

put more profit in



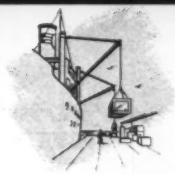
Spiroid Gears are manufactured by conventional methods or can be sintered, die cast or molded in a variety of metals and plastics. Size and weight savings are truly remarkable.



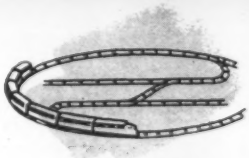
Ratios 9:1 to 300:1

Any Size

EARMOTORS



HOISTS and WINCHES



TOY TRAINS

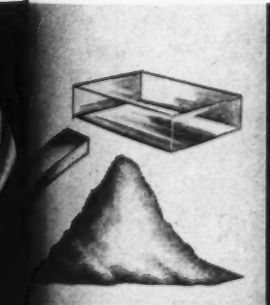
ELECTRIC MIXERS

POWER SEATS

...in your product ...with SPIROID® GEARS

Any reduction in the size of your product reduces production costs . . . giving you a larger profit margin. Spiroid Gears do just this. A completely unique design principle permits much shorter center distance between shafts . . . increases load carrying capacity. The result: smaller, lighter geared mechanisms. For example, a ⅓ HP. 30:1 gearmotor can be made with nearly 30% less space and weight! Spiroid Gears offer almost unlimited design opportunities in many other ways, too. Investigate them now . . . to put more profit in your product!

SPIROID GEAR DIVISION
2501 N. Keeler Avenue
Chicago 39, Illinois



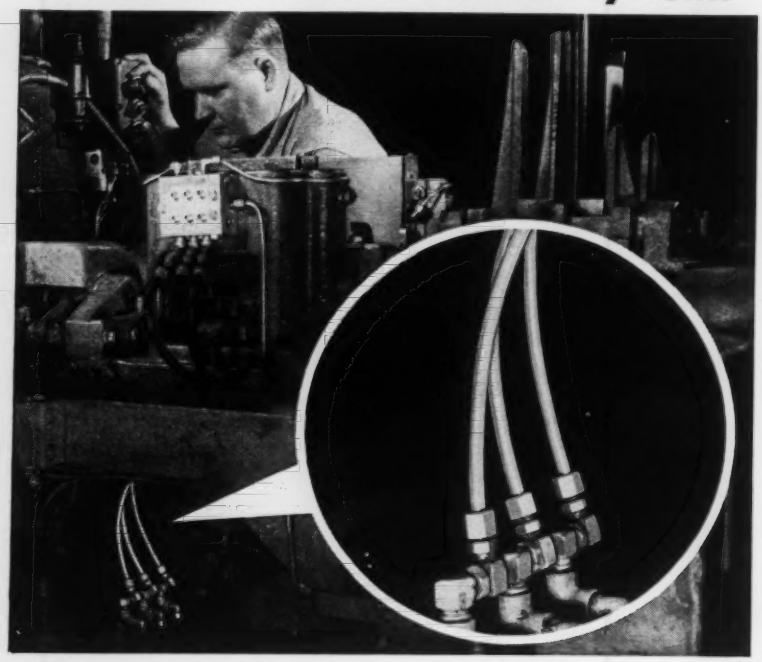
Any Material

ILLINOIS TOOL WORKS

SEND FOR THIS NEW BOOKLET
"More Power from Less Space" shows exactly how Spiroid Gears can put more profit in your product. Write for your copy today!

Circle 595 on page 19

NYLAFLOW® Pressure Tubing cuts costs on machine tool lubrication systems



• High-speed production soon becomes "high-cost" production in the face of frequent downtime and expensive maintenance. Polymer's NYLAFLOW Pressure Tubing — specially processed from tough, horn-like nylon — helped solve this problem recently on a series of automatic machines:

PROBLEM:

Tubing connecting automatic lubricator to moving parts was required to withstand 400 flexes per minute under high internal pressure. Frequent failure due to pressure and flex fatigue of tubing caused excessive downtime, costly maintenance.

SOLUTION:

NYLAFLOW Pressure Tubing has been in continuous use for 12 months without a single replacement. This represents an increase in tubing life—*thus far*—25 to 1 over former tubing. NYLAFLOW required no special fittings, was less bulky and easily installed.

These characteristics show why tubing costs are low with NYLAFLOW:

- Flexibility—extremely long flex life.
- High Pressure Rating — higher strength / weight ratio than any other extruded non-metallic tubing.
- Easy Installation—light weight, easy to handle and cut, no pre-bending, uses standard fittings.
- Corrosion Resistant—impervious to most chemicals, hydrocarbons, solvents.
- Impact and Abrasion Resistant—withstands accidental blows which permanently dent metal tubing, resists surface wear.

Solve your tubing problems permanently with economical NYLAFLOW. Available in burst strengths of 1000 and 2500 psi. in various diameters. Write for performance data.

THE POLYMER CORPORATION OF PENNA. • Reading, Penna.
Export: Polypenco, Inc., Reading, Penna., U.S.A.

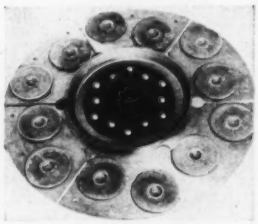
POLYPENCO Nylon, Teflon†, Q-200.5 (cross-linked polystyrene) and K-51 (chlorinated polymer)

*PATENTS APPLIED FOR
†DU PONT TRADEMARK

Circle 596 on page 19

New Parts

(*Continued from Page* 185)



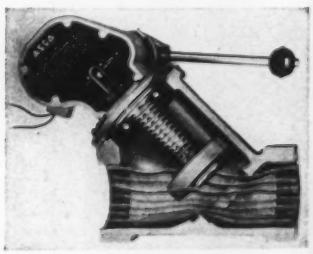
clutch plates up to 14 in. diam, and twelve on either side of larger plates. Disks are mounted back to back on either side of the clutch plate, held in place with one tubular rivet per pair. Air circulation through space between individual disks helps rapid dissipation of heat. Due to retention of friction resistance at extreme heat conditions, the ceramic-faced clutch plates provide a 50 per cent increase in load carrying capacity and up to five times longer useful life than conventional linings. **Lipe-Rollway Corp.**, 806 Emerson Ave., Syracuse, N.Y.

Circle 468 on page 19

Solenoid Valve

safety shut-off type for gas supply lines

Safety shut-off, manual reset, solenoid valves, for use in gas supply lines leading to boilers, furnaces, and other heating equipment, close the line automatically and instantly upon power failure. Valves are designed to control flow of manufactured, natural, and L-P gases at maximum temperature of 104 F, may be used for various grades



of fuel oil and noncorrosive liquids and gases. Sizes are available from ¾ to 6 in. IPS; pressures from 25 to 100 psi. Y-type body provides flow nearly equal to straight-through gate-type valve. Integral crown seat and soft com-

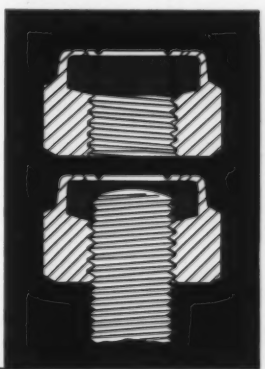
What's special about this STOP NUT?

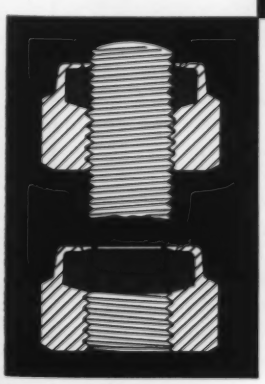
Several things make this nut unusual. For instance, you can "stop" it at any position on the threaded length of the bolt . . . or wrench it tight against the work where it protects bolt threads against corrosion and prevents liquid leakage. No matter where you leave it on the bolt, it will remain tight in that exact position, even though you subject it to heavy vibration and shock loads. But use a wrench on it and it comes off as easily as it went on. The red locking collar is nondestructive—does not gall bolt threads or remove plating. You can remove it and re-use it again and again.

What gives it its grip?

1 The locking collar is unthreaded and elastic. It has an inside diameter smaller than the major diameter of standard bolts.

2 The bolt impresses a mating thread into the collar and the resulting compressive forces exert a constant friction grip on the bolt. . . .





3 and exert a downward thrust bringing the lower flanks of the bolt thread into firm metal to metal contact with the matching nut threads, eliminating normal axial play.

4 Nut is removable and reusable . . . the Red Elastic Collar retains its grip after repeated usage.

Will it hold under ALL conditions?

The locking principle of the Elastic Stop® nut has been tested and proved by over 25 years of actual field service. Elastic Stop nuts are used on locomotives . . . and pile drivers. They fasten hedge shears and harvesters, drilling rigs and washing machines, trucks and roller skates. And no Elastic Stop nut customer has ever stopped using them because of unsatisfactory performance.

What about sizes and materials?

Elastic Stop nuts are available from a watchmaker's 0-80 all the way to 4"—in materials that include stainless steel, brass, aluminum and other alloys. Protect your product with "fastener insurance." Try Elastic Stop nuts on trouble spots, whether to protect expensive heavy equipment from costly downtime or to guarantee the accuracy of delicate electrical equipment by maintaining precision adjustments. We'll supply free test samples.

ESNA® TRADE MARK

ELASTIC STOP NUT CORPORATION OF AMERICA

Dept. N82-84, 2330 Vauxhall Road, Union, N. J.

Please send the following free fastening information:

☐ ELASTIC STOP nut bulletin

☐ Here is a drawing of our product. What self-locking fastener would you suggest?

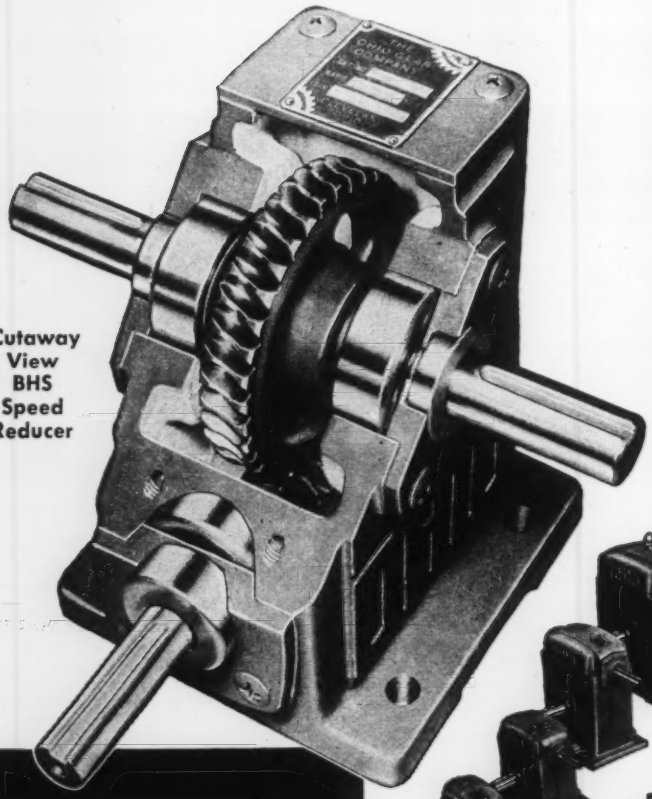
Name_____ Title_____

Firm_____

Street_____

City_____ Zone_____ State_____

Circle 597 on page 19



Cutaway View BHS Speed Reducer

HU Series

PL Series

HS Series

D Series

OHIO STOCK SPEED REDUCERS

off the shelf

Accepted by nationally known manufacturers for

- Sound engineering
- Sturdy construction
- Long economical operation
- Variety of sizes, ratios and capacities
- Widest range of power transmission
- Ratios 4-1 to 3200-1

ESTABLISHED 1915

OHIO GEARS

SEE OUR NEAREST DISTRIBUTOR OR WRITE DIRECT

THE OHIO GEAR COMPANY

1338 East 179th Street • Cleveland 10, Ohio

Circle 598 on page 19

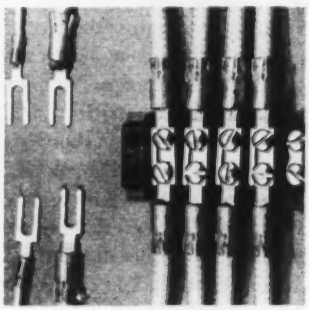
New Parts

position disk give absolute shut-off and double Buna N rubber seals on valve stem prevent leakage. Valve closes when solenoid is de-energized but may be closed manually. A normally-closed valve is also available. Power consumption is 10.5 w ac or 10 w dc. **Automatic Switch Co.**, 391 Lakeside Ave., Orange, N. J.

Circle 469 on page 19

Terminal Connectors

have fork-tongued design for low-resistance connection



Designed specifically for use with terminal blocks, these fork-tongued terminal connectors span two opposite screws of the terminal strip to provide a low-resistance connection. Multifinger insulation grip gives resistance to vibration and prevents insulation creep. Three basic sizes of the connectors accommodate the complete cable range. They are supplied uninsulated, or insulated with either nylon or high-temperature Kel-F. **Burndy Engineering Co. Inc.**, Omaton Div., Norwalk, Conn.

Circle 470 on page 19

Generating Plants

have reversed cooling flow to allow buried installation

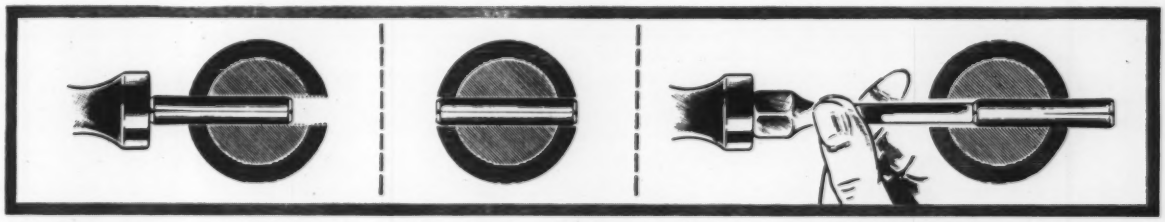
Optional feature on a line of electric generating plants in ratings from 500 to 5000 w is a unique reversed cooling flow system. Cooling air, which moves in reverse of the conventional direction, is pulled over the generator by a large centrifugal blower, passes through the engine, and is then expelled through an outlet duct. Also supplied in a complete line of air-cooled engine-driven equipment,

what makes this fastener DIFFERENT?

Several things. Rollpin® is a slotted, chamfered, cylindrical spring pin which drives easily into a hole drilled to normal production standards. It locks securely in place, yet can be drifted out and reused whenever necessary. This eliminates special machining, tapping, and the need for hole reaming or precision tolerances. Rollpin replaces taper pins, straight pins and set screws; for many applications it will serve as a rivet, dowel, hinge pin, cotter pin or stop pin.

And here's another difference that makes Rollpin the quality fastener in the field: ESNA's quality control builds consistent strength and performance into every Rollpin. Rollpin is uniform as to shear strength, dimensions, hardness, and insertion and removal forces.

HOW YOU INSERT IT



Drives easily by hammer, arbor press, or air cylinder and can be readily adapted to an automatic hopper feed. Requires only a standard hole, drilled to normal production-line tolerances.

Locks securely in place without using a secondary locking device; won't loosen despite impact loading, stress reversals, or severe vibration.

Removes readily with a drift pin without damage to pin or hole, can be used again and again in original hole.

HOW YOU SAVE

You pay less for Rollpins than for most tapered, notched, grooved or dowel pins. Installation costs are substantially less than for any fastener requiring a precision fit or secondary locking operations.

Because of their tubular shape, Rollpins are lighter than solid pins. Production maintenance is reduced with Rollpins: they do not loosen and because of their spring action they tend to conform to the drilled hole in which they're inserted, without material hole wear, eliminating the necessity of re-drilling or using oversize pins.

MATERIALS AND SIZES

Standard Rollpins are made from carbon steel and Type 420 corrosion resistant steel. They're also available in beryllium copper for applications requiring exceptional resistance to corrosive attack, good electrical, anti-magnetic, and non-sparking properties. Stock sizes range from .062" to .500" in carbon and stainless steels.

ROLLPIN®

ESNA

ELASTIC STOP NUT CORPORATION OF AMERICA

Dept. R40-84, 2330 Vauxhall Road, Union, New Jersey

Please send me the following free fastening information:

- ☐ Rollpin Bulletin
- ☐ Elastic Stop nut Bulletin
- ☐ Here is a drawing of our product. What self-locking fastener would you suggest?

Name _____ Title _____

Firm _____

Street _____

City _____ Zone _____ State _____

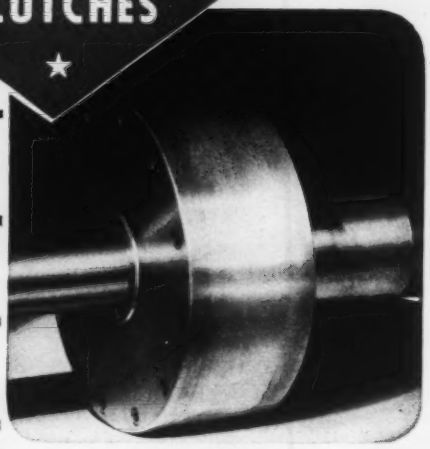
FOR POWER CONTROL DESIGNS USE
HILLIARD
Over-Running
CLUTCHES

1 LONG LIFE because the rolls have no localized wear points.

2 NO JAMMING even after long wear.

3 ACCURATE because of individual spring pressure on each roll.

4 RENEWABLE CAM SURFACES for increased life without machining or new parts.



50 YEARS of satisfactory service proves you can depend on Hilliard Over-Running Clutches and Couplings for long service on—

- DUAL DRIVES for pumps, fans, blowers and boiler stokers. (Many installations have a record of over 20 years without repair.)
- TWO SPEED DRIVES for dry cleaning machines, laundry equipment, conveyors, paper processing machines, slitters, forming rolls and automatic machinery.
- RATCHET ACTION for printing press ink rolls, coal feeders, press feeds, honing machines, bakery equipment and conveyors.
- BACK STOP SERVICE on textile machines, speed reducers, elevating conveyors and in combination with ratchet feeds.
- WRITE TODAY FOR BULLETIN 231 WITH COMPLETE INFORMATION.

OTHER HILLIARD CLUTCHES:

SINGLE REVOLUTION CLUTCHES for automatic accurate control—electrical or mechanical—of intermittent motion, indexing, cycling and cut-off. Ask for Bulletin 239.

SLIP CLUTCHES for overload protection, or constant torque and to provide constant tension and permit speed variation on rewind stands. Ask for Bulletin 300.

HILLIARD - TWIFLEX CENTRIFUGAL COUPLING for smooth, easy starting of any load automatically with overload protection and ability to accommodate shaft misalignment. Ask for Bulletin CE-3.

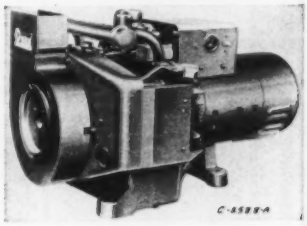
★ CONSIDER AUTOMATION - INVESTIGATE THESE PRODUCTS

103 W. FOURTH ST. ELMIRA, N. Y.

IN CANADA: UPTON • BRADEEN • JAMES, LTD.

Circle 600 on page 19

New Parts



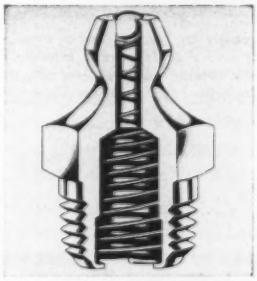
the system eliminates the need for auxiliary cooling on driven units, which can be generators, compressors, pumps, etc. Compact compartment housing the engine-generator combination permits buried installation and is easily soundproofed. For cold-weather operation, engine running temperatures can be controlled by thermostatically operated shutters in the air-outlet scroll. **D. W. Onan & Sons Inc.**, University Ave., S. E. at 25th Ave., Minneapolis 14, Minn.

Circle 471 on page 19

Lubrication Fitting

has colored identifying tip

Long service life is provided by the case-hardened, thick-wall construction of these Red Ball hydraulic fittings, which have a red ball in the tip for quick identification. Designed to provide up to



35 per cent greater working angularity while maintaining a perfect seal, the fittings give clean, fast flow of lubricant. **Stewart-Warner Corp.**, 1826 Diversey Pkwy., Chicago 14, Ill.

Circle 472 on page 19

Photoconductive Cell

tiny unit has high sensitivity

Subminiature cadmium-sulfide photoconductive cell, designated 6694-A, has high luminous sensitivity,

R B&W FASTENER BRIEFS

RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY

Technical-ities

By John S. Davey

What's the right torque for bolts?

This is one of the toughest questions we're asked. Too many variable conditions. But the following may help.

The bolt takes two stresses during wrenching: (1) Torsion, (2) Tension. Tension is what you want. Torsion is the necessary evil due to friction. Probably 90% of applied torque goes to overcome friction.

With the friction factor changed by lubrication, plating, etc., the torque needed to produce a given tension is hard to predict. However, a useful empirical formula exists for *normal* friction conditions.

Inch-lbs. Torque = 0.2 x bolt diameter x bolt tension

Many tests show that the 0.2 torque coefficient is approximately constant for the usual friction conditions, for all diameters, and for both coarse and fine thread. Average deviation is about 7%. But when are conditions *"normal"?* The only *sure* way to check torque is to set up a pilot assembly and try it out.

In pilot testing for rigid joints, tighten a few bolts with torque wrench to failure, and then set torque at 75% of that load; or even at yield strength, since torsion component vanishes leaving bolt under tension only, which is well below ultimate strength.

We've worked up curves giving suggested torques for various size bolts. Send for a copy.

How to make a stronger joint

From research on structural steel joined with high strength bolts come facts applicable to *products:*

These bolts can be torqued to high tension for a large clamping force on joined members. Resultant friction overcomes shearing forces and prevents slippage. The higher compressive forces also protect bolt holes from fatigue cracks. Moreover, the tighter the bolt, the less chance for loosening, and the less risk of bolt fatigue due to dynamic loading.

High strength bolts are stronger in shear, too. In recent tests, rivets and "soft" bolts broke under extreme shear load; but high strength bolts didn't—the joined steel failed first.

APPLYING THE ADVANTAGES

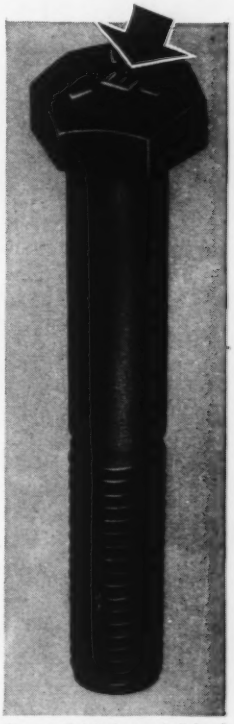
Since high strength bolts have 2 to 3 times more tightening strength than common bolts, smaller diameter bolts can be used. As discussed above, these make a stronger joint; also weigh and cost less.

Along with good joint design, it's important that fasteners used can meet requirements. For example: A manufacturer designed vibrating machinery for high tensile bolts, but it was assembled with low carbon bolts. Joints failed. RB&W high carbon bolts with hardened washers solved the problem.

Moral: *Specify* even your standard fasteners.

RB&W selects the proper grade of steel to give "Empire" high strength fasteners the precise balance between *tensile strength* and *ductility.*

Feel free to call on RB&W for help in selection and use of standard, low cost fasteners.



Three radial dashes on bolt head denote a high strength bolt. The "E" identifies Empire bolts, an RB&W trademark. These markings assure highest quality standard fasteners with full strength, and uniformity of size and physicals.

●

Russell, Burdsall & Ward Bolt and Nut Company . . . plants at: Port Chester, N. Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. Additional offices at: Ardmore (Phila.), Pa.; Pittsburgh; Detroit; Chicago; Dallas; San Francisco.

Silicon bronze fasteners combine desirable features

Silicon bronze offers the highest conductivity of fasteners able to withstand high stresses. It resists corrosion, stays free from season cracking, too. It makes ideal fasteners for electrical use where tensile strength is important; or for corrosive environments.

One of the first to develop such fasteners, RB&W cold works them for tensile strength and for clean, well formed threads that don't seize. Oval bolts, hex bolts and nuts and U bolts available. Specials can be developed.

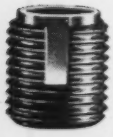
Circle 601 on page 19

SUB MINIATURES

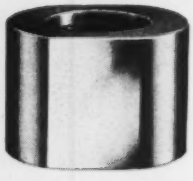
Now you can get sub-miniature "key-locking" inserts in 0, 1, 2, 3, and 4 thread sizes. Sub-miniatures, made only by Kelox, offer design engineers the opportunity for making small assemblies even smaller and lighter. Identical to regular Kelox inserts, these new "key-locking" sub-miniatures will not rotate or loosen with vibration . . . provide maximum holding power . . . save weight and space.

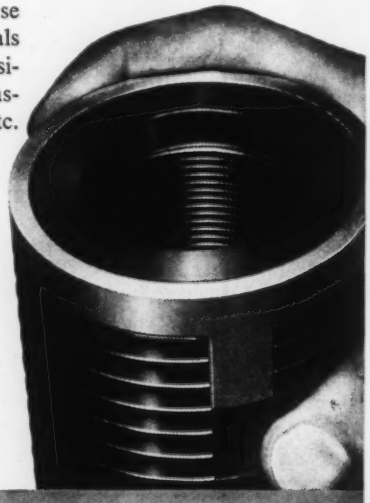
SAVE WEIGHT...
SAVE SPACE
with KELOX®

The Kelox system of threaded and tapped inserts offers the ultimate in weight- and space-saving design. Maximum holding power between parent and bolted piece is obtained because patented "key-locking" produces no stress concentrations and permits complete use of external threads. Independent laboratory tests have verified that "key-locking" successfully withstands application of maximum torque.



Low cost, easy-to-install Kelox inserts are available for internal thread sizes from 0 to 3 inches. Made of many materials (alloy steel, corrosion-resistant steel, brass, aluminum alloy, monel, etc.), Kelox inserts are also available with thin or thick walls for use with various materials —aluminum, magnesium, "pot" metal, plastic, titanium, steel, etc.





EXTRA LARGE

For big assemblies, Kelox extra large inserts (up to any specified diameter) give unmatched performance—performance that verifies the soundness of Kelox exclusive "key-locking" principle. Only Kelox offers you a positive, non-rotating insert that does not break down protective coatings like ceramic . . . requires no special threads . . . gives maximum reduction of space and weight.

KELOX® **Fasteners, Inc.**
580 Fifth Avenue
New York, New York

SALES REPRESENTATIVES—

Universal Fasteners Co.
Centerville Road, P. O. Box 449
Sturgis, Michigan

F. D. Barringer Company
542 Spring Street, N. W.
Atlanta 3, Georgia

Monogram Manufacturing Co.
8357 Higuera Street
Culver City, California

D. R. & W. Technical Service Company
P. O. Box 4
East Hartford, Connecticut

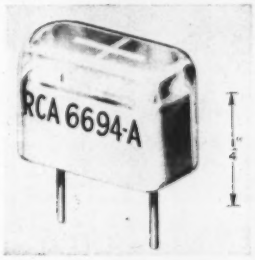
Scott Fittings Limited
339 Bering Ave., P. O. Box 169
Toronto 18, Canada

AZ74

Circle 602 on page 19

New Parts

low dark current, extremely low background noise, and a signal output which is approximately proportional to the incident light intensity. Radiant sensitivity at 5000 angstroms is 415 microamp per microwatt; luminous sensitivity is 1 amp per lumen. Luminous-intensity sensitivity is 4 microamp per foot-candle. Sensitivity is directly proportional to the applied



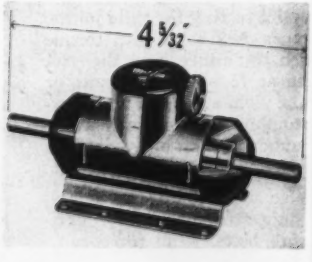
voltage within the rating of the cell. Cell is applicable in light-controlled relay installations, and in light meters where brightness of small luminous spots is desired. **Radio Corp. of America,** Tube Div., 115 S. Fifth St., Harrison, N. J.

Circle 473 on page 19

Speed Changer

6-oz unit has range of 25 to 1

Adjustable-ratio speed changer incorporates anodized aluminum end bells, with two ball bearings for each shaft, to provide accurate concentricity between input and output shafts and to minimize effect of impact, vibration, and temperature changes. Six-oz unit delivers 0.025 hp and 5 to 40 oz-in. torque, depending upon selected ratio. Speeds up to 10,000 rpm are permissible. Ratio of input to output speeds is infinitely adjustable between 1 to 5 up and 1 to 5 down, a total range of 25 to 1; dial pointer indicates ratio. Six

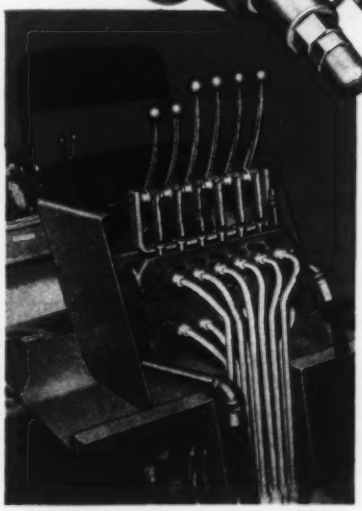


Why is it so important *to YOU* that 7 out of 9 builders of Backhoe Diggers use HYDRECO Hollow-Plunger Control Valves? Analyze the functions involved in this Fluid Power application, and the answer is clear. Here is a rugged service application requiring multiple manual control of Fluid Power operations, good throttling, and easy-to-reach controls. All these features are combined in Hydreco Hollow-Plunger Valves to give the operator a feeling of "playing" the machine.

Hydreco Hollow-Plunger valves are perfect for this application. Check valves built into the plungers absolutely prevent back flow and cross flow between cylinders, therefore rapid sequence of operations is possible on multiple cylinder machines.

The Hydreco valve enables the operator to level, dig, hoist, swing and dump quickly and easily. The operator has the touch he needs to get the best out of a good machine, day in and day out. That's why operators like Hydreco Hollow-Plunger Valves.

Designers like Hydreco valves too, because with all components built in, they come smaller and fit into tight places more easily. For smoother operation, for more work at less cost — apply HYDRECO Hollow-Plunger Valves to your multiple-function equipment!



Hydreco valves are available with up to 6 plungers.

Member NFPA

KALAMAZOO DIVISION
THE NEW YORK AIR BRAKE COMPANY

9006 E. MICHIGAN • KALAMAZOO • MICH.

INTERNATIONAL SALES OFFICE, 90 WEST ST., NEW YORK 6, N. Y.

Kalamazoo Division
The New York Air Brake Company
9006-8 East Michigan
Kalamazoo, Michigan

Kindly send me full information on Hydreco Hollow-Plunger Control Valves.

Name_____

Company_____

Address_____

City_____ Zone____ State____

Circle 603 on page 19

just one call
...that's all!

Blue Devil

Socket Screw Products

One call does it all . . . because your Blue Devil Distributor has a complete line of socket screw products. His large stock plus that of Blue Devil's factory and warehouse stocks means all your regular and emergency needs can be quickly filled. Why not call him today?

Socket Set Screws
Socket Cap Screws
Flat Head Cap Screws
Socket Shoulder Screws
"Saf-Lok" Socket Screws
"Led-Lok" Socket Cap Screws
Socket Pipe Plugs
Socket Screw Keys

ACTUAL CROSS-SECTION DIAGRAM shows how cold forming of Blue Devil Socket head insures unimpaired fiber continuity.

Member ASMMA

Sold Only Through Authorized Industrial Distributors

SAFETY SOCKET SCREW COMPANY

6510 North Avondale Avenue • Chicago 31, Illinois
Warehouses at: Los Angeles • San Francisco • Detroit • New Haven, Conn.

Socket Screws Exclusively!

Circle 604 on page 19

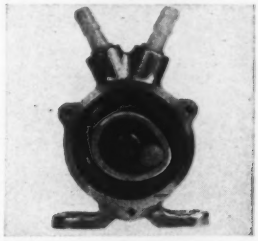
New Parts

speed controls are available: thumb screw (shown), push rod, lever arm, and spur, miter, or worm gear. The unit is designed for use in radar jammers, aerial camera shutters, recorders, computers, and similar applications requiring remote or automatic control. **Metron Instrument Co.**, 432 Lincoln St., Denver 3, Colo.

Circle 474 on page 19

Pump

for small-capacity corrosive applications



Design of a low-capacity pump employs a minimum of parts for service on a wide range of corrosive chemicals. Nylon roller in the pump is driven in a planetary motion about the drive shaft. Roller presses against vinyl tube-guard which, in turn, kneads the vinyl pumping tube carrying fluid, imparting positive directional flow to fluid or gas being pumped. Tubing may be supplied in any of a wide range of materials to suit specific applications. Capacity varies from 3 oz per min, at 250 rpm (4.3-psi) to 19 oz per min at 1500 rpm. At 26.0-psi, capacity is 6 oz per min at 1500 rpm. Pump is available with or without 1/25-hp motor. **Becher Pump Co.**, 852 Belmont Ave., Chicago 14, Ill.

Circle 475 on page 19

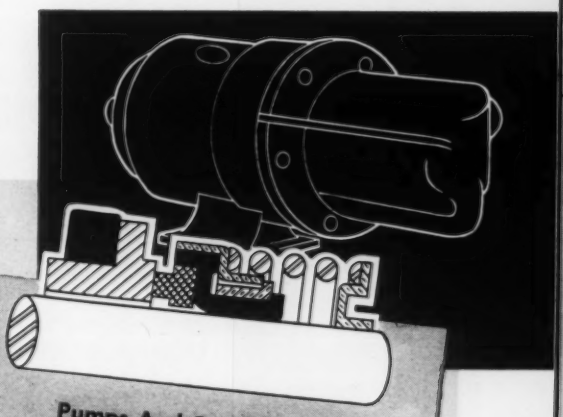
Flexible Coupling

has integral brake drum

Incorporating a brake-drum flange on its outer diameter, this flexible coupling provides a compact drive arrangement and is particularly useful where shaft length or distance between two connected units is at a premium. It is available in eight standard sizes with horse-

Machine Tools And Power Transmission Equipment

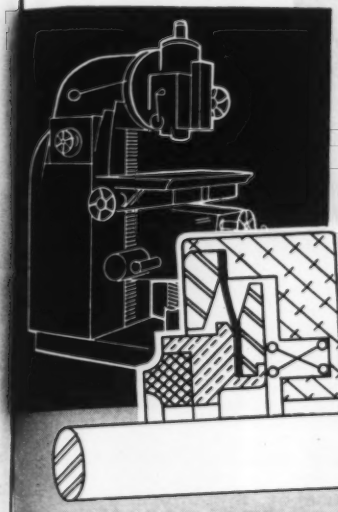
STYLE GU — A packaged sealing unit containing both rotating and stationary seal faces enclosed in metal housing. Stock sizes for shafts .250 through 4.000.



Pumps And Compressors

ROTO-FLEX — Rugged flexibility. Only 3 parts. Single or double units. Stock sizes for shafts .250 through 4.000.

STYLE RFO — A specially designed Roto-flex seal, for installation outside the stuffing box. Stock sizes for shafts .250 through 4.000.



Heavy Machine Tools

STYLE DPC — A high-speed, carbon-faced seal, for more compact installation in heavy industrial machinery. Stock sizes for shafts .250 through 4.000.

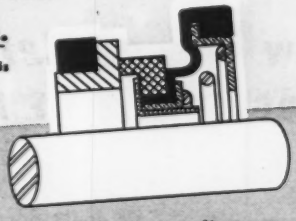
A Complete Line GITS SHAFT SEALS For Every Application

These modern, mechanical, face-type seals are carried in stock — to save you time and money. Write for detailed data.

GITS BROS. MFG. CO.

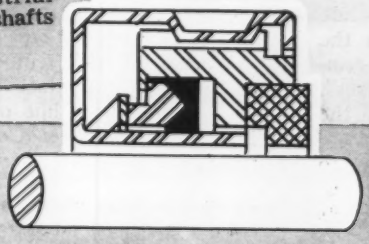
1868-A South Kilbourn Avenue • Chicago 23, Illinois

Specialists In Lubricating Devices And Shaft Seals For Almost Half-A-Century



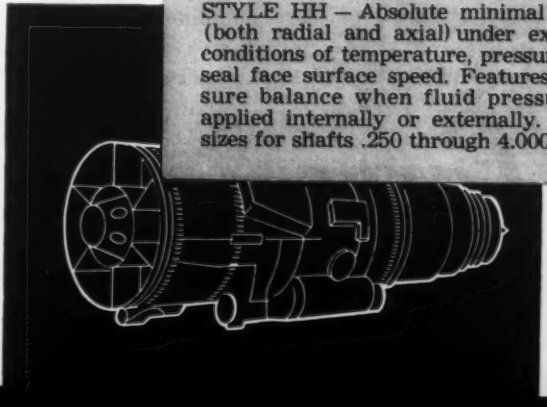
Household Appliances

STYLE SGU—A factory-assembled unit-type seal for the small-budget user. Stock sizes for shafts .250 through 1.000.

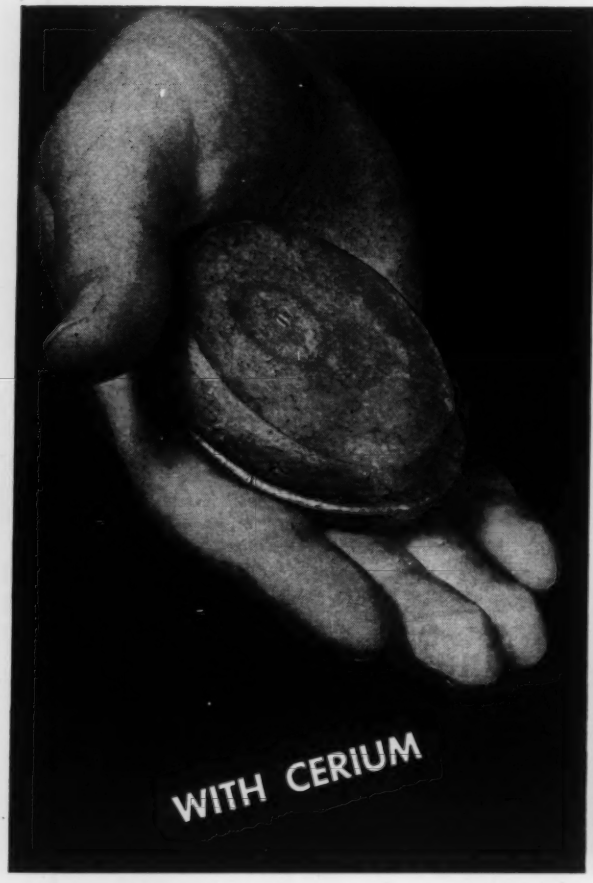


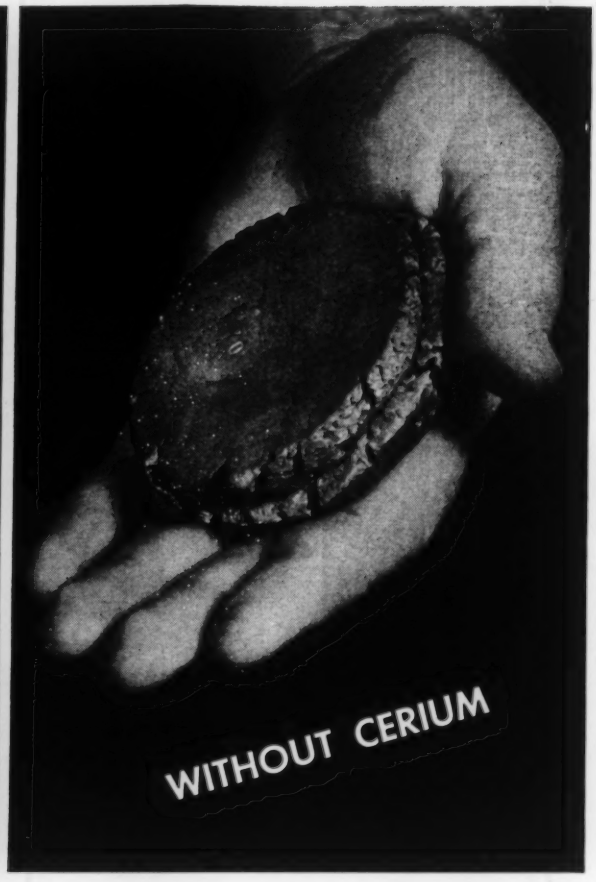
Aircraft Engines And Accessories

STYLE HH — Absolute minimal space (both radial and axial) under extreme conditions of temperature, pressure and seal face surface speed. Features pressure balance when fluid pressure is applied internally or externally. Stock sizes for shafts .250 through 4.000.



Circle 605 on page 19





HOW *Carpenter* USES RARE EARTH ELEMENTS TO IMPROVE FORGEABILITY OF ALLOYS FOR ELEVATED TEMPERATURE SERVICE

The value of rare earth elements in certain alloys for elevated temperature service can be seen in this hot forgeability test. Cast cones, identical except for the addition of cerium in one, are heated to forging temperature and upset or hammered into flat "pancakes". Note the relative freedom from cracks and tears in the specimen containing cerium.

What does this improved hot workability mean to you? It means better forged finishes requiring less machine clean-up . . . less wasted steel . . . fewer rejects . . . faster fabricating.

Carpenter alloys for elevated temperature service have an enviable reputation for improved forgeability, and exceptional cleanness which meets the strictest inspection requirements.

Carpenter pioneering in tool steels, super corrosion resisting steels and free-machining stainless steels has helped hundreds of companies to improve products and cut costs. This same specialty mill experience can help you do a better, low cost job on any parts or products you make for high temperature service. It'll pay you to investigate. Contact your Carpenter Representative, or drop us a line on your company letterhead. *The Carpenter Steel Company, 120 W. Bern St., Reading, Pa.*

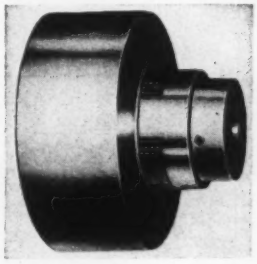
Specify Carpenter alloys for elevated temperature service and get these three big advantages . . .

Improved Forgeability
Greater Uniformity
Cleaner Steel

Carpenter STEEL

Improved Alloys for Elevated Temperature Service

Circle 606 on page 19



power ratings from 2 to 40 hp at 1750 rpm. Maximum hub-body bores range from 1 to 2½ in.; drum-body bores are made to motor shaft specifications. Distance between shafts runs from ½ to 1⅝ in. **Lovejoy Flexible Coupling Co.**, Dept. MDC, 4801 W. Lake St., Chicago 44, Ill.

Circle 476 on page 19

Titanium Wire Cloth

for corrosive screening applications

Industrial grades of wire cloth are woven from titanium wire, in mesh sizes from 60 mesh through coarser sizes. In highly corrosive filtering or screening applications, the titanium wire cloth, in one instance, has been in use for over seven months with no indication of corrosive attack; previously used stainless steel cloth evidenced severe pitting after two or three weeks of service. Uses include medical prosthetics, screening hypochlorite and chlorine dioxide in the pulp and paper industry, and aircraft jet-engine screens. **Cambridge Wire Cloth Co.**, Cambridge, Md.

Circle 477 on page 19

Silicon Diode

miniature unit has 1000-v capacity

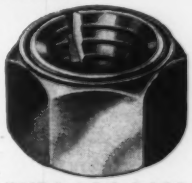
High voltage diodes have peak inverse voltage classifications of 600

(*Continued on Page 202*)

...for
CRITICAL FASTENING PROBLEMS
specify Delron
specialized fastening devices

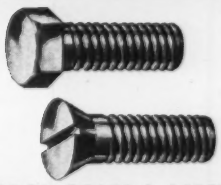
High Temp, Self-locking, Stainless Steel Nuts — Free Spinning On Lock... Unlock, Free Spinning Off — Reusable.

DURA-LOC 1200
(temperatures up to 1200° F.)

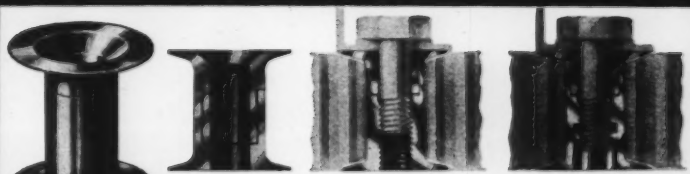


DURA-LOC 1600
(temperatures up to 1600° F.)

DURA-LOC WASHER-NUT
All-metal, self-locking nut with integral washer. For keyhole type flange mountings at temperatures up to 550° F.



DELRON BOLTS & SCREWS
High Temp, Stainless Steel Bolts and Screws for temperatures to 1600° F. Special thread form minimizes galling.



FASCO THRU-BOLT SPACER
FASCO THREADED SPACER
FASCO THREADED SELF-LOCKING SPACER

FASCO SPACERS for Honeycomb Structural Panels
Lightweight, High Column Strength Aluminum Spacers available in a variety of designs, for assembling and attaching to honeycomb sandwich-type structural panels.

Illustrated are a few of the many Delron Specialized Fastening Devices designed to help solve your critical fastening problems!

Need data on a specific fastening problem?

Clip this ad to your letterhead, and mail for product data on items checked: MD

☐ Fasteners to 1200°F. operation
☐ Fasteners to 1600°F. operation
☐ Sandwich structure fastening

Name_____

THE DELRON COMPANY, INC.
5224 Southern Avenue, South Gate, California

Circle 607 on page 19

Stearns announces new

CLASS II

explosion-proof brake

* Class II hazardous locations include Group E — Atmospheres containing dusts, including aluminum, magnesium and their commercial alloys; Group F — Atmospheres containing carbon black, coal or coke dust; Group G — Atmospheres containing flour, starch and grain dust.

GROUPS E, F and G*

for hazardous locations

Underwriters Laboratories Approved

Now Stearns offers for the first time an explosion-proof brake that can be used with safety in locations where combustible dust creates a hazard to men and equipment. This new Stearns explosion-proof magnetic disc brake has been tested and approved by Underwriters Laboratories for use in Class II, Groups E, F and G* hazardous locations as defined by the National Electrical Code.

Now design engineers and motor manufacturers can *safely* provide the instant stop-start and holding advantages of magnetic disc brakes on electric motors in hazardous locations where no *approved* brake formerly was available.

The new magnetic brake is available in the Stearns 70 Series with maximum torque ratings of 10, 25, 50 and 75 lb ft, floor or motor mounting. All the advantages and the outstanding quality of Stearns magnetic disc brakes have been retained in the new explosion-proof design features which long have made Stearns brakes the favorite among motor manufacturers. For example:

QUICK TORQUE SETTING

The torque of Stearns brakes can be set simply by turning one adjustment nut.

SIMPLE PARTS REPLACEMENT

Maintenance-minded machine designers appreciate the simplicity of Stearns magnetic disc brakes. The entire actuating mechanism can be quickly removed, thus providing easy access to the friction elements and other operating parts. The single solenoid coil can be replaced readily and inexpensively.

BALL BEARING MECHANISM

The linkage from the solenoid on Stearns brakes operates smoothly on ball bearings to reduce wear on sliding surfaces, assuring long life and trouble-free service.

RUGGED CAST CONSTRUCTION

To assure strength and rigid stability, Stearns brakes feature cast construction of enclosures and many components. High-grade cast iron, bronze and aluminum guarantee the exceptional quality and stamina industrial service demands.

STYLED TO HARMONIZE

Stearns engineers know that "eye appeal" frequently is important in the design of electrical equipment. Contours of Stearns brake enclosures are pleasing and functional, blend naturally with the smooth lines of the electric motors with which they are coupled.

A proved leader in explosion-proof brake design

Stearns' developments in the field of explosion-proof brakes also include the industry-proven UHF brake for use in Class I, Group D hazardous locations — areas subject to explosive gases and fumes. In addition, Stearns manufactures a complete line of standard magnetic disc brakes for use on 1/20th to 100-hp motors in a wide variety of applications. Stearns brakes are standard equipment on major motor lines. Specify Stearns on your next motor brake order.

Write for Brake Portfolio 604F or call your local Stearns representative.

Stearns ELECTRIC CORPORATION

formerly STEARNS MAGNETIC INC.

692 SOUTH 28th STREET • MILWAUKEE 46, WISCONSIN

Circle 608 on page 19

Durakool Tilt Switches are the Life of your Automatic Controls

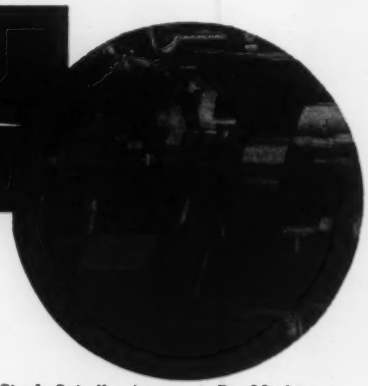
This steel-clad Durakool mercury tilt switch has unique construction features that deliver years of trouble-free performance on the most difficult assignments you can find. Operating under sealed-in, pressurized hydrogen gas, it takes 24 hours, fast cycling schedules in stride. 7 sizes, 1 to 65 amperes. Send for Bulletin 525.

See telephone directory for local distributor, or write.
DURAKOOL, INC.
ELKHART, INDIANA, U.S.A.---700 WESTON RD., TORONTO 9, CANADA

Durakool ALL-STEEL MERCURY *Switches*

Circle 609 on page 19

SPLIT SECOND
COOLANT FLOW
with Ruthman GUSHER
Coolant Pumps



Illustrated is a Cleveland Dialamatic Single Spindle Automatic Bar Machine equipped with a Gusher Coolant Pump.

Model 5-P 3

Your Gusher Coolant Pump is always primed and ready to deliver coolant instantaneously. There is no lag — no waiting for the flow to start — and you can easily regulate the volume from a trickle to full capacity.

Pre-lubricated ball-bearings, electronically balanced rotating shaft, and totally enclosed dustproof motor assure you also of long trouble-free life for your Gusher Coolant Pumps.

THE RUTHMAN MACHINERY CO.
1811 Reading Road — Cincinnati, Ohio

Circle 610 on page 19

New Parts

(*Continued from Page* 199)

v, 800 v, and 1000 v, with half-wave dc output currents of 125 ma at 75-C ambient temperatures. Operating temperature range is −55 C to +150 C ambient. Diodes occupy volume of 1/16-cu in., being only ⅜-in. diam by 9/16-in. long, less length of pigtail leads. Hermetically sealed for freedom from contamination, diodes are designed for stability and reliability in applications such as high-voltage bias supplies, computing machines, guided-missile circuits, airborne radar, and replacement of vacuum rectifier tubes. **International Rectifier Corp.,** Product Information Dept., 1521 E. Grand Ave., El Segundo, Calif.

Circle 478 on page 19

Scale Dials

ten-turn units read to 1 part in 1000

Direct reading concentric scale dials 1¾ in. in diam are available with black bakelite knobs and eight combinations of dial finish. Turn-counting dial reads up to 10 turns and distinguishes between tenth turn and zero point. Increment dial has 100 divisions, is mounted on actuating shaft to eliminate backlash, and gives indexing accuracy of 1 part per 1000. Unit is available with or without finger tip brake. **George W. Borg Corp.,** Borg Equipment Div., Janesville, Wis.

Circle 479 on page 19

Variable-Speed Drives

use interchangeable parts for wide power and ratio range

Line of variable-speed drives, called Vari-Mount, features standard, interchangeable components;

Circle 611 on page 19→

if you make ELECTRICAL equipment ...

you should know about SHARON SPECIAL STEELS

SHARONSTEEL

For more than 50 years Sharon has been a prime producer of the steels needed most by the electrical industry.

For such products as meters, outlet boxes, motors, controls, transformers, etc., Sharon produces hot and cold rolled special strip steels in large coils, cut lengths or sheets.

If you want exactly the right steel for the job, call in the man with experience in providing steel for the electrical industry — your Sharon Steel Salesman.

Typical products used by leading electrical manufacturers include:

STAINLESS — both straight chrome and chrome-nickel
ELECTRICAL STEELS — field, armature, electrical and motor grades
COATED STEELS — Galvanite*, Brite Zinc, Electro Galvanized, Terne
FORGING INGOTS and BILLETS
SPRING STEELS — of every analysis
SHARONART — the steel with the rolled-in surface design
N.A.X. and COR-TEN — hi-tensile low-alloy steel

Electrical Manufacturers

Should Have These Booklets:

430 STAINLESS — a complete review of a popular straight chromium grade.

GALVANITE* — The story of one of the most popular hot dip zinc coated steels.

SHARONART*—Rolled-in design steels with excellent illustrations.

*Trademark registered by Sharon Steel Corporation

SHARON STEEL CORPORATION *Sharon, Pennsylvania*

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there's no premium for precision

with

"Fischer Turned"

BRASS AND ALUMINUM NUTS

Costing no more than nuts produced by other, less accurate methods, Fischer precision-turned brass and aluminum nuts make possible important savings in assembly operations. Check these advantages:

Countersunk on both sides for faster starting . . .

Tapped square with face to Class 2 tolerances for smoother, easier running and superior bearing surfaces . . .

Turned from stock under basic size so they're never tight on wrenches . . .

Tapped through, eliminating "blanks" or rejects . . .

Cleaned and degreased before delivery to save you these operations.

Specify Fischer on your next order. A complete range of standard types and sizes is maintained in stock . . . "specials" can be produced quickly and inexpensively.

Write today for Catalog No. 55

Fischer SPECIAL MFG. CO.

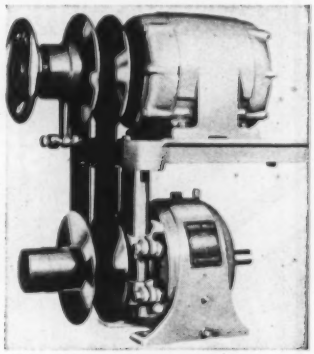
451 Morgan St. • Cincinnati 6, Ohio

TURNED NUTS Fischer SPECIAL MFG. CO. CINCINNATI OHIO SINCE 1906

C-284-FS

Circle 612 on page 19

New Parts



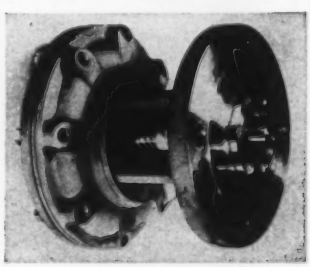
all units are designed to accommodate standard motors. Capacities are from one to 15 hp, with maximum speeds from 711 to 15.1 rpm and minimum speeds from 355 to 2.5 rpm. Speed adjustment ranges to 6:1 can be provided. Drives, available in vertical or horizontal models, can be operated by remote or manual control. **Foote Bros. Gear and Machine Corp.,** 4545 S. Western Blvd., Chicago 9, Ill.

Circle 480 on page 19

Pressure Transmitter

for service with viscous substances

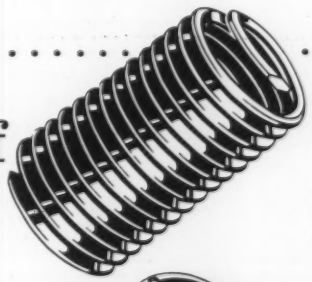
Operating on the force-balance principle, model P pressure transmitter is lightweight, rugged and highly sensitive. It is especially adapted for service with viscous substances, or with materials which solidify in static pressure lines. It also has application for liquid-level indication on open tanks containing viscous materials, or those with solids in suspension. Flat di-



aphragm is rubber, Teflon, or stainless steel, depending on the temperature range and corrosiveness of the service. Supersensitive pilot is isolated from the pressure diaphragm so that controlled gas

now HELI-COIL* offers 3 types of inserts for 3 types of applications

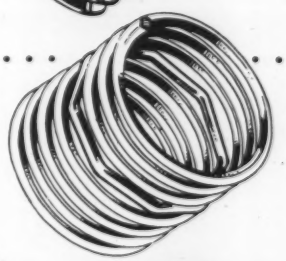
1 for strip-proof wear-proof threads



HELI-COIL SCREW-THREAD INSERTS

These precision-formed coils of wire form vastly superior permanent threads in tapped holes. They are corrosion-proof, strip-proof and so strong that even in soft metals excessive torque will shear off the bolt before the female threads will strip. This means smaller, fewer fastenings—less bulky design.

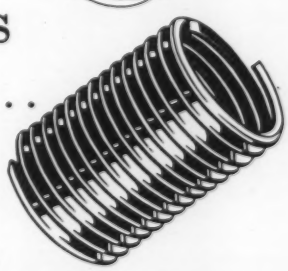
2 to eliminate cumbersome locking devices



HELI-COIL "MID-GRIP" SCREW-LOCK INSERTS

Now designers can do away with lock nuts and lock wiring and all their attendant problems of space, weight, cost, and difficult assembly. This new fastener is a stainless steel wire insert with locking threads that put the locking action *inside* the tapped hole, holding standard screws or bolts with the same torque as a lock nut, and protecting the tapped threads for life.

3 to eliminate tapping costs



HELI-COIL PUSH INSERTS

Provide ready-made female threads — no drilling or tapping — for non-structural parts. Often less than one cent per thread installed. Can be pushed direct into cast or molded, blind or through-holes in soft, light materials. Tool up for a few dollars.

*Reg. U. S. Pat. Off.

accept these 3 HELI-COIL SERVICES

to bring an early end to your threaded fastening problems

3548

HELI-COIL CORPORATION
128 Shelter Rock Lane, Danbury, Conn.

- ☐ Send complete catalog file on all 3 types of *Heli-Coil* Inserts.
- ☐ Have nearest *Heli-Coil* Applications Engineer call to study my problem, advise how *Heli-Coil* Inserts can help.
- ☐ Put my name on subscription list for "Heli-Call," free case history periodical.

Name_____ Title_____

Company_____

Address_____

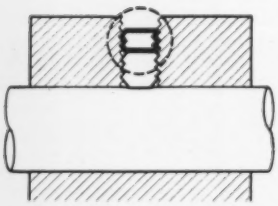
City_____ Zone_____ State_____

In Canada: W. R. Watkins Co. Ltd., 41 Kipling Ave. S., Toronto 18, Ont.

MAC-IT tips for better fastening:

STOP SET SCREW SLIPS!

...with Mac-it Hollow Lock Screws



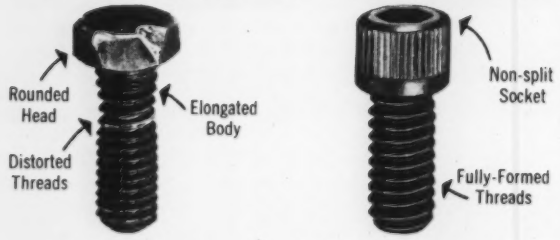
Excessive speed and vibration can't shake loose a socket set screw when the Mac-it Hollow Lock Screw is on the job! Why? Because it's tightened *against the set screw* to produce "internal lock nut" action.

This Mac-it Hollow Lock Screw is a tough customer! It's made of high-grade alloy steel—carefully heat treated throughout for a fine, uniform grain structure. Accurate socket and threads hold their shape even after thousands of adjustments.

Because the hex socket goes all the way through, assembly is quick and easy: a set screw and lock screw may be tightened separately or together using the same key—and the set screw may be re-set without removing the lock screw.

Your local distributor carries complete stocks of Mac-it Hollow Lock Screws in sizes #6 to 1", either N.C. or N.F. threads, Class 3 fit. Ask him for free samples and literature.

AVOID SCREW FAILURES!



Ordinary Cap Screw — Mac-it Socket Head Cap Screw

...SPECIFY MAC-IT

Screw failures are hazardous! Workmen can be injured, equipment damaged and down-time increased unnecessarily.

Mac-it Screws are protected against such failures by their "built-in" toughness—over twice the "tensile" of ordinary cap screws. This is achieved through expert heat treatment of high grade alloy steel.

Because the head will not twist off and the socket will not split, a Mac-it Screw can be driven tighter. Once the fully-formed threads take their grip, they assure stronger fastening.

Don't put up with the false economy of inferior grade screws. Specify Mac-it. Your local distributor stocks a wide variety of Mac-it screw types and sizes. Ask him for free literature and samples, or write:

Mac-it Screw Division
STRONG, CARLISLE & HAMMOND
1392 West Third Street • Cleveland 13, Ohio

Circle 614 on page 19

New Parts

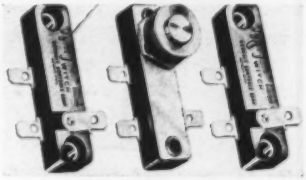
or liquid cannot back up into air lines in event of diaphragm failure. **Conoflow Corp.**, 2100 Arch St., Philadelphia 3, Pa.

Circle 481 on page 19

Snap-Action Switch

has high contact life

Fully-enclosed TyniSwitch is 1⅝ in. long, 9/32-in. thick and 7/16-in. wide. Mechanism is of simple design,



having only one moving part. Use of a single stamping provides positive snap action; patented blade design makes possible positive maintenance of contact. Available in pin-operated models having operating force from 3 to 12 oz and in wire-operated types with force from 1½ to 12 grams. **Detroit Controls Corp.**, TyniSwitch Dept., 800 Union Ave., Bridgeport, Conn.

Circle 482 on page 19

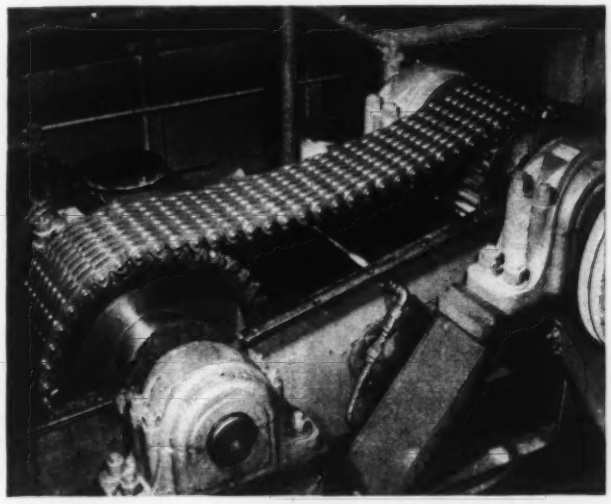
Epoxy Resin Adhesive

has high strength, long life

Exceptionally high shear strengths are provided by a one-part epoxy resin adhesive which requires no accelerators or catalysts. Designated EC-1386, it has unlimited working life, and eliminates errors inherent to the mixing of two-part adhesives. Designed for metal bonding over a service temperature range from −65 to 250 F, it gives good adhesion to brass, steel and aluminum. Use is intended in industrial and aircraft applications where exceptionally high shear strength at temperatures to 180 F is required. Flexibility gives high bending strength and greater resistance to cracking or shattering under shock or bending loads. High strength bonds are obtained by curing the adhesive at 350 F. **Minnesota Mining and Mfg. Co.**, Adhesives and Coatings Div., 411 Piquette Ave., Detroit 2, Mich.

Circle 483 on page 19

Why the design engineer is ahead when specifying LINK-BELT Silent Chain

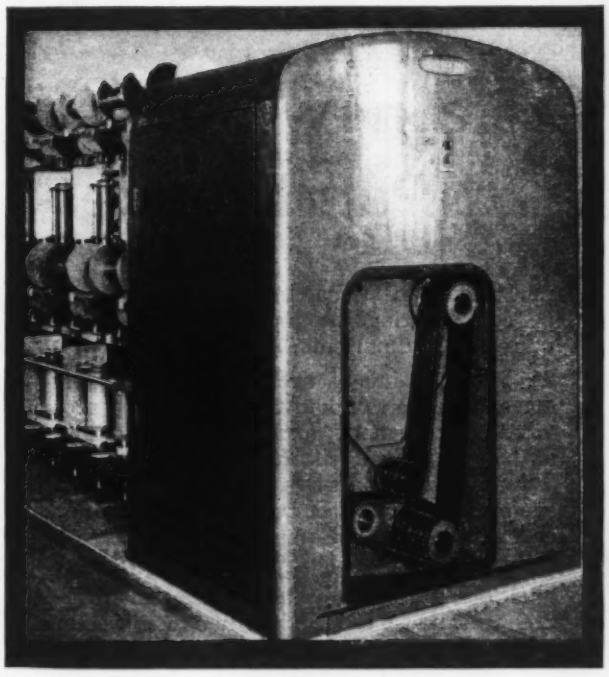


Silent chain driving from a 200-hp, 1200-rpm motor handles comfortably the extreme peak loads of draw bench service.

No other drive does so many jobs so well

In applications involving the transmission of fractional or thousands of horsepower, high rotative or linear speeds—no other drive can match the effectiveness of Link-Belt silent chain.

You are assured of better than 98% sustained efficiency throughout its long life. It is often lower in first cost and always lower in ultimate cost—frequently runs for 20 to 30 years with only routine attention. Get the full story on Link-Belt silent chain. Write for Book 2425, or call your nearby Link-Belt office.



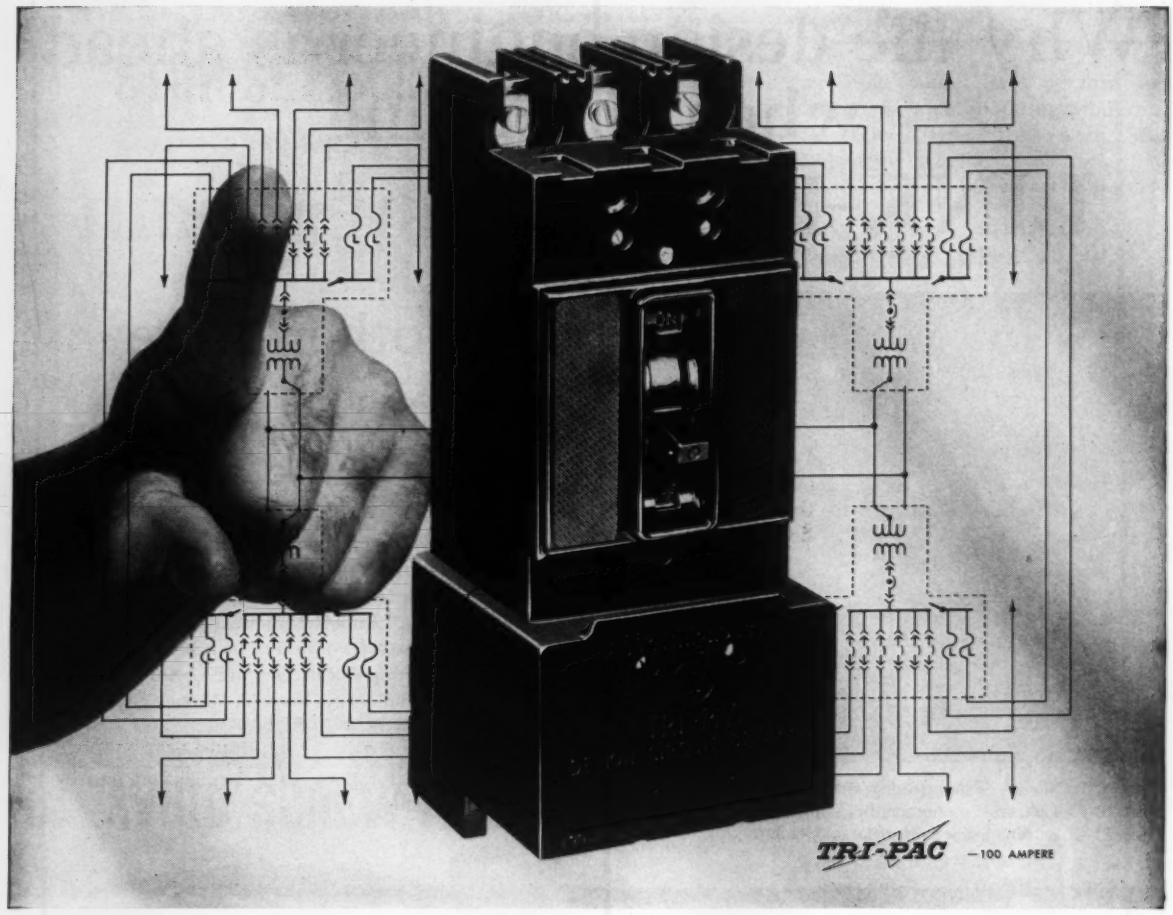
Uptwister uses duplex silent chain. Note the simplicity of this drive operating multiple shafts in a textile mill.

LINK-BELT

CHAINS AND SPROCKETS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13,935

Circle 615 on page 19



100,000 amps gets a new boss—the Westinghouse Tri-Pac breaker

The new Westinghouse Tri-Pac breaker is the smallest protective device for electrical circuits where 100,000 amps can be poured into faults. It is the most practical and economical solution to the constantly increasing interrupting requirements of network systems and those fed by large transformers.

Co-ordinated triple circuit protection—thermal, magnetic, and current limiting—combines the inherent advantages of both the molded case breaker and fusible current limiters. The breaker trip portion of the Tri-Pac handles overloads and moderate faults, eliminating fuse replacement. On higher currents, the current limiters in Tri-Pac trip before the breaker portion, insuring the prompt protection required at high currents.

Tri-Pac costs much, much less than large air current breakers of equivalent rating and provides more safety and convenience than switches combined with fusible elements. New Tri-Pac breakers insure positive protection against all system current faults—large or small—at a new and greater economy.

A Westinghouse sales engineer can show you additional reasons why the new Tri-Pac breaker is your best buy for powerful circuit system protection. Call him, today. J-30216

WATCH WESTINGHOUSE!

COVER THE PRESIDENTIAL CAMPAIGN ON CBS TV AND RADIO!

ENGINEERING
DEPARTMENT

EQUIPMENT

Tracing Templates

aid rapid drawing of threaded fasteners

Profile and detail drawing of threaded fasteners is speeded by four transparent vinylite templates. A small machine screw template covers flat, oval, round, binding and fillister head screws from No. 6 to 5/16-in. diam. Screw threads with pitches from 20 to 4 are drawn with the second tem-

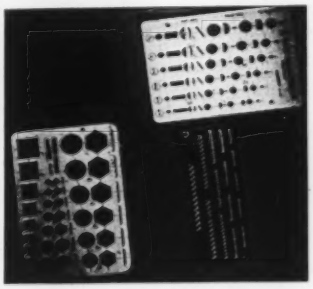


plate. The screw-head template provides for side and top elevations of square and hex head fasteners. A general dimensioner template completes the series, components of which are available both singly and as a kit. **A. Lawrence Karp**, 16 Putnam Park, Greenwich, Conn.

Circle 484 on page 19

Spring Tension Gage

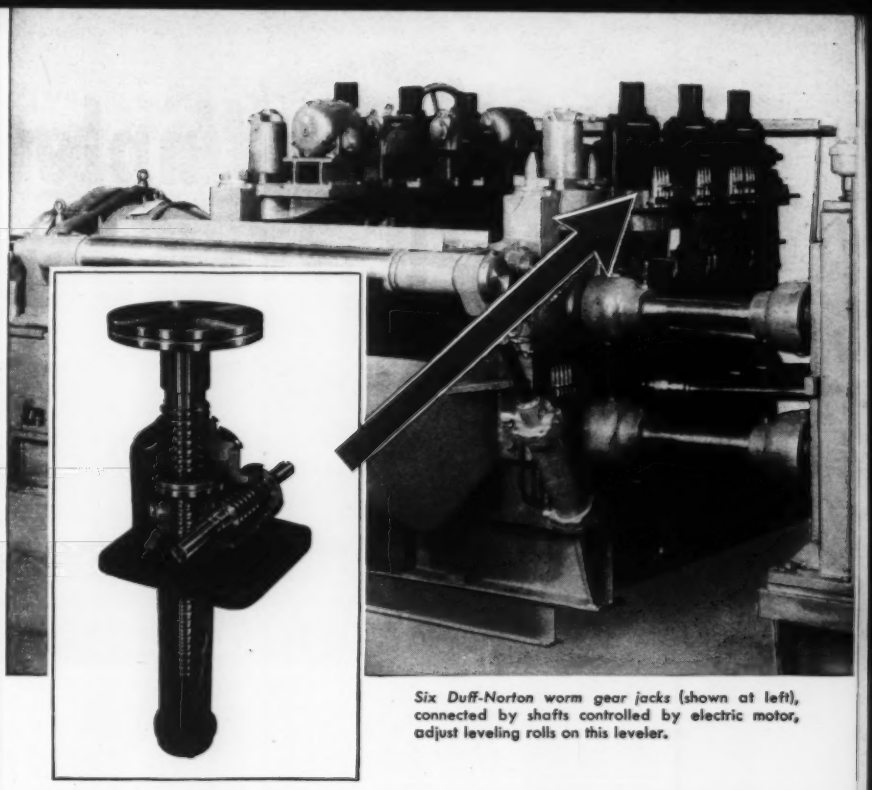
pocket size unit is calibrated in grams

For checking tension of delicate springs in electronic and similar

applications, this gage is available in four models: Model 70-D reading 50-0-50 grams in 5-gram steps,

(*Continued on Page* 212)

Circle 617 on page 19→



Six Duff-Norton worm gear jacks (shown at left), connected by shafts controlled by electric motor, adjust leveling rolls on this leveler.

Here's a device every machinery designer should know about

It's the Duff-Norton worm gear jack, successfully used by many machine builders as a component of equipment for precise, positive control of linear motion; applying pressure; resisting impact. Two or more of these jacks can be connected by means of shafting and mitre gear boxes to give a positive drive, so that jacks always raise or lower under equal or unequal loads in perfect unison. Capacities range from 5 to 50 tons with any raise up to 25 inches; worm gear ratios, 8:1 to 45:1; turn of worm for each 1 inch raise, 10 to 180; available in either Acme or square threads. For protection against foreign matter certain models of these jacks can be furnished with bellows boots.

Thousands of these jacks are in use today for table adjusting—machine adjusting—rolling mill adjusting — raising and lowering conveyors, machine beds, molds and dies, furnace lids, loading platforms, loading racks, gates, hinged mechanisms, arbor presses — adjusting electrodes — overhead crane servicing.

Duff-Norton worm gear jacks are made in 6 standard sizes. Write for booklet!

Duff-Norton Company

DUFF-NORTON COMPANY
Department MD
P. O. Box 1889, Pittsburgh 30, Pa.

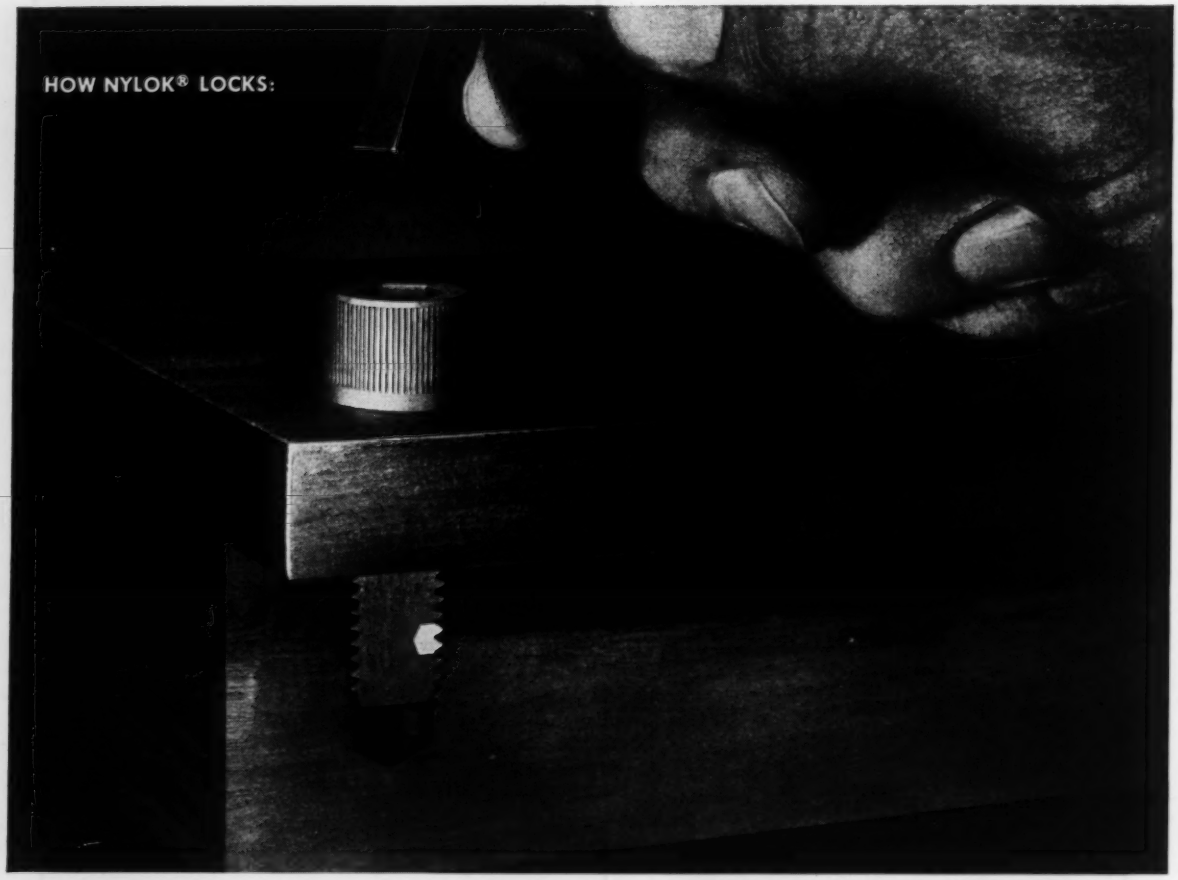
Please send immediately a free copy of your new Worm Gear Jack Brochure.

NAME _____ TITLE _____

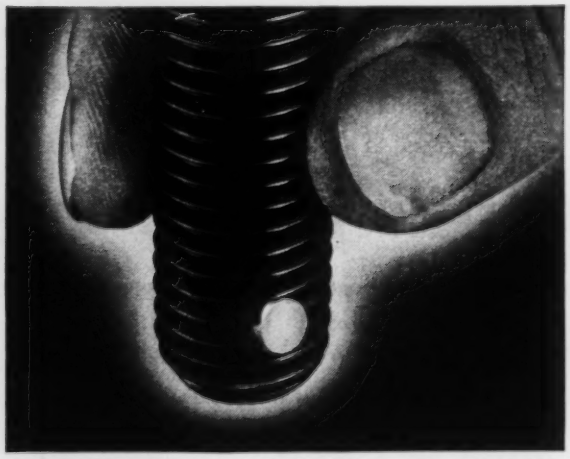
COMPANY _____ PHONE _____

ADDRESS _____

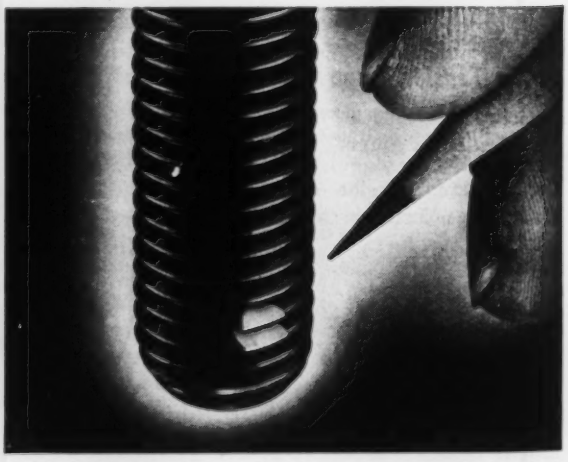
NEW—a complete line of socket screw products



LOCKED! The tough, resilient nylon pellet keys itself into the mating threads. It forces threads together, and locks the screw securely.



BEFORE ASSEMBLY. The nylon pellet projects slightly beyond male threads. When assembled, female threads will be impressed into it. Pellet locks effectively whether the screw is seated or not.



AFTER REMOVAL. "Plastic memory" of pellet has expanded impressed threads to greater diameter than screw threads. Screw can be used repeatedly. In use, "memory" keeps threads tightly locked.

self-locking UNBRAKO that won't work loose

They simplify design and save production time

UNBRAKO socket screws are now available embodying the Nylok* self-locking principle. Nylok provides a truly practical new solution to the problem of making screws self-locking.

An UNBRAKO screw with Nylok is a single self-locking unit. No auxiliary locking devices are needed. Just thread the UNBRAKO into any tapped hole. *Seated or not*, it locks positively wherever wrenching stops. The tough, resilient nylon pellet forces mating threads together and holds tight. The screw will not shake loose.

You save production time when you build products with self-locking UNBRAKOS. And you get greater simplicity in design with less bulk and weight. The number of parts you must assemble to achieve full locking action is reduced to the absolute minimum. Lockwashers under screw heads are no longer necessary. Costly wiring of cross drilled heads is eliminated. So are cotter pins and complex multiple set screw installations.

Self-locking UNBRAKOS are completely reusable. They have uniform locking and installation torques—with no galling or seizing on mating threads. They successfully withstand temperatures from —70° to 250°F. And, on properly seated screws, the pellet acts as a liquid seal.

Self-locking UNBRAKO socket screws come in a complete range of standard sizes and materials. See your authorized industrial distributor. Technical data and specifications are detailed in Bulletin 2193. Write us for your copy today. Unbrako Socket Screw Division, STANDARD PRESSED STEEL CO., Jenkintown 18, Pa.

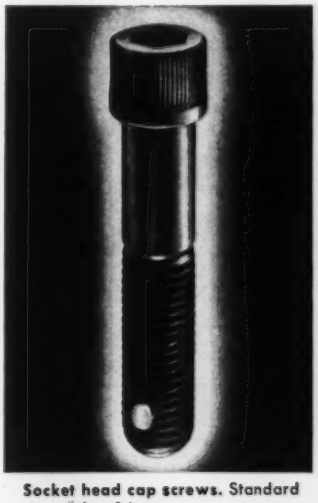
T.M. Reg. U.S. Pat. Off., The Nylok Corporation

UNBRAKO SOCKET SCREW DIVISION

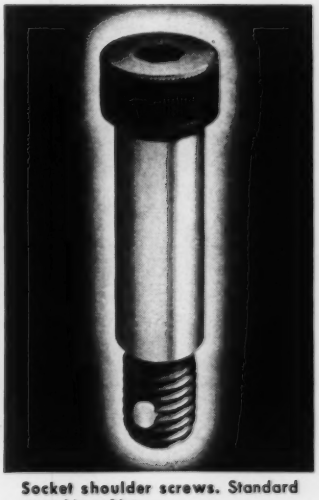
STANDARD PRESSED STEEL CO.

SPS

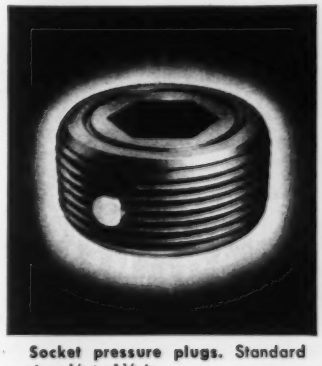
JENKINTOWN PENNSYLVANIA



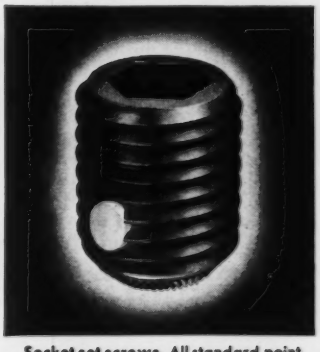
Socket head cap screws. Standard sizes #6 to 1 in.



Socket shoulder screws. Standard sizes ¼ to ¾ in.

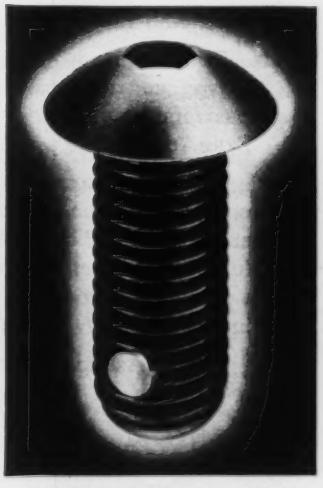


Socket pressure plugs. Standard sizes ⅛ to 1¼ in.



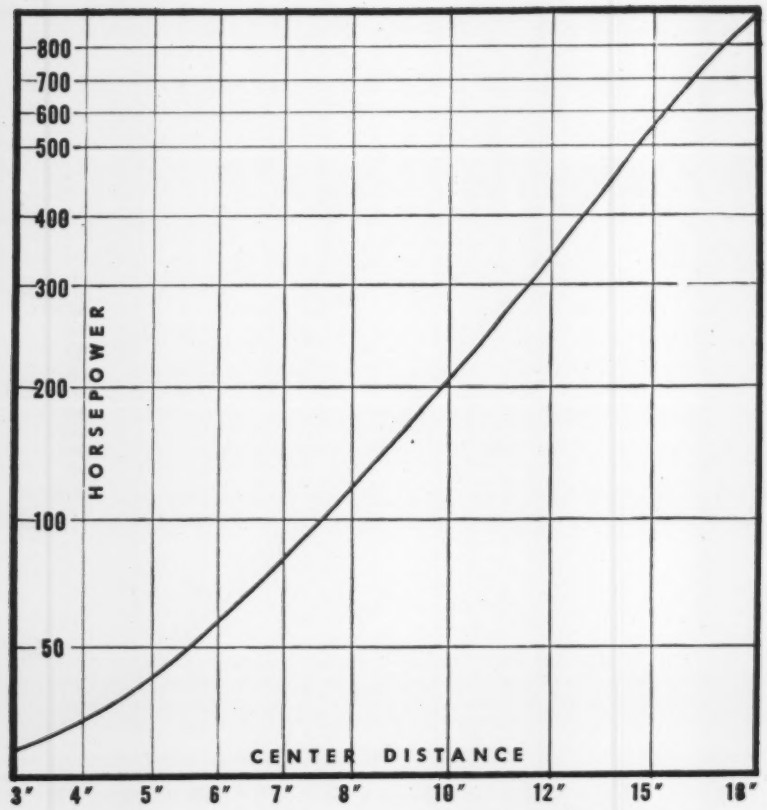
Socket set screws. All standard point types. Standard sizes #6 to 1 in.

Flat head socket screws. Standard sizes #6 to ¾ in.



Button head socket screws. Standard sizes #6 to ⅜ in.

Circle 618 on page 19



WE LEFT COMPETITIVE RATINGS OUT OF THE CHART PURPOSELY..

. . . because we think the load-carrying capacity of Cone-Drive speed reducers is pretty impressive all by itself. Then, we've also got a lot of friends in the worm gear speed reducer business. And they make pretty fair reducers themselves.

Two things are responsible for the high capacity of Cone-Drive speed reducers. First, we use extra-heavy gears mounted on oversize taper roller bearings in reinforced, heavy housings. Extra "beef' alone accounts for part of our capacity.

Even more important, however, is the Cone-Drive double-enveloping worm gear design. Here, we literally wrap worm and gear around each other to put ⅛ of all teeth in continuous full-depth contact. This results in spreading tooth contact over a greater area, reducing pressure on individual teeth, increasing load capacity and life of the gearing.

Ask for Bulletin 600C without obligation.

CONE-DRIVE GEARS
DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS
Division, Michigan Tool Company
7171 E. McNichols Road • Detroit 12, Michigan

Circle 619 on page 19

Engineering Equipment

(Continued from Page 209)

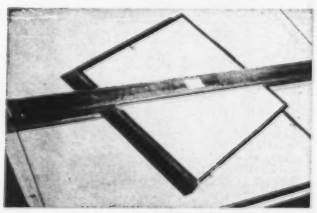
Model 70-H reading 30-0-30 grams in 2-gram steps, Model 70-F reading 10-0-10 grams in 1-gram steps, and Model 70-J reading 0-150 grams in 5-gram steps. Indicating spring gives reliable standard of measurement and is protected by folding handle when not in use. Size overall is 4½ in. by 1½ in. **P. K. Neuses Inc.**, W. Euclid and Dwyer St., Arlington Heights, Ill.

Circle 485 on page 19

Tracing Table

may be used under string straightedges

Extra-thin tracing table, only $1\frac{7}{16}$-in. thick, is lightweight and portable, yet sufficiently strong to allow tracing on bristol board. Low height and flush top enables unit to be used under large drawings and allows string straightedges to



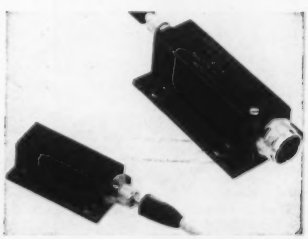
pass over. Unit has Plexiglas top, fluorescent lighting, and rubber feet. Four sizes range from 11 by 18 in. to 24 by 36 in. **Porta-Trace Inc.**, Dept. MD, 342 Clinton St., Binghamton, N. Y.

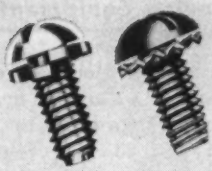
Circle 486 on page 19

Accelerometer System

withstands 300 F temperatures without external cooling

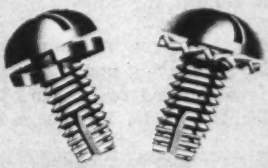
High - temperature accelerometer system, incorporating an accelerometer and external cathode follower, measures shock and vibration at temperatures up to 300 F





SPRINGTITES AND SEMS

SNAP RINGS

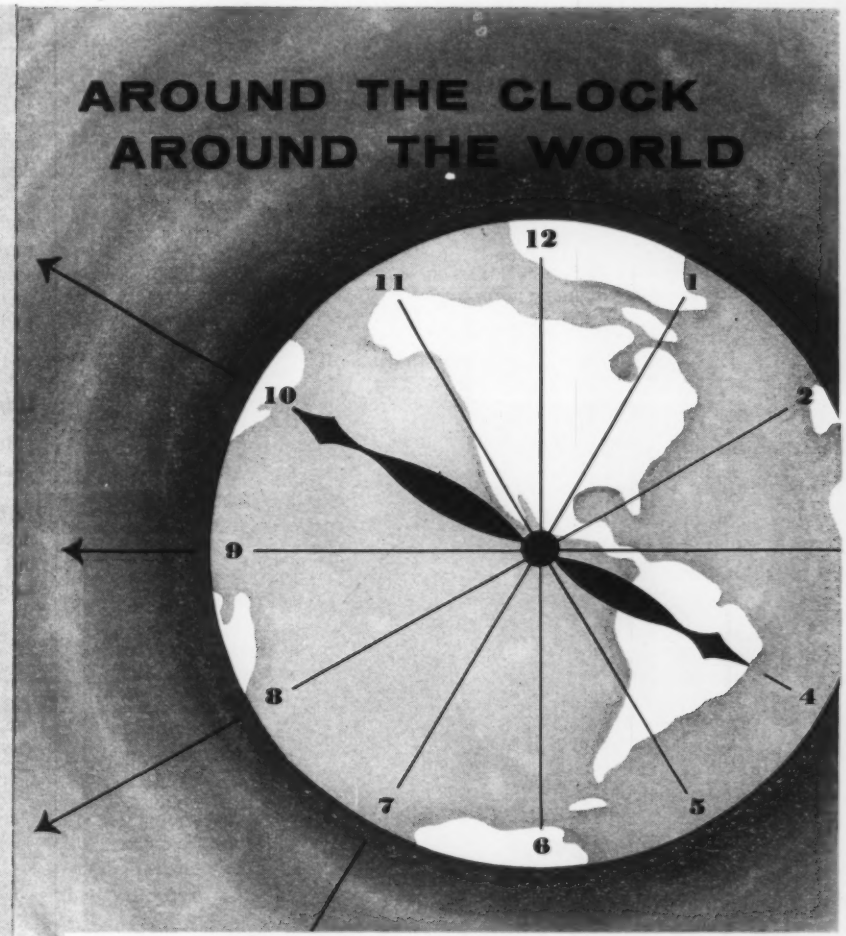


THREAD-CUTTING SPRINGTITES AND SEMS

EATON KEPS®

HOZ-FAS-NERS®

SPRING LOCK WASHERS



Eaton-Reliance Fasteners Keep Assemblies Tighter Longer

Used to advantage wherever assemblies are fastened together, Eaton-Reliance products will be found throughout industry . . . railroad, automotive, appliance, electric, heavy and light machinery, aircraft, and many others. They are manufactured of quality controlled materials to rigid specifications, and are designed to reduce assembly costs and speed up production. There's an Eaton type fastener for your particular needs. Send for free Engineering Bulletin giving details. Just name the fasteners in which you are interested.

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MANUFACTURING COMPANY

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Circle 620 on page 19

JOT NAME, TITLE AND ADDRESS IN THIS SPACE
TO START YOUR FREE "NELWELDER" SUBSCRIPTION

another way of saying...

Nelson Stud Welding Gets There Fast and Easy

You're on the road to greater fastening savings when you pick up a lightweight, go-anywhere Nelson stud gun. Nelson stud welding gives manufacturing and construction a real lift. There's no tapping, no drilling, less material handling . . . fewer bosses and flanges required, too. And once you've welded, the studs stay put! Engineers throughout industry read the NELWELDER for tips on end-welding studs to steel the fast, easy way. Why not hike your profits, too? Get on the mailing list by sending the top of this ad.

NELSON STUD WELDING
Division of Gregory Industries, Inc.
LORAIN, OHIO

Circle 621 on page 19

Engineering Equipment

without external cooling. Frequency response is 10 to 2000 cps, and acceleration range is up to 300 g. Sensitivity is 20 microvolts per g, output impedance is 200 ohms and accuracy is 5 per cent. Designated Glennite KAHT-310, the system can be used in environmental testing. **Gulton Mfg. Corp.**, 212 Durham Ave., Metuchen, N. J.

Circle 487 on page 19

Lubricant Tester

for bonded coatings and liquid lubricants

Lubricant testing machine is primarily for testing bonded coatings, but is also used for testing liquid lubricants. Model LFW-1, a small

table model, maintains high loading accuracy, indicates friction forces throughout the test, and has a presetting device which automatically stops machine when a predetermined coefficient of friction is reached. **Alpha Molykote Corp.**, 65 Harvard Ave., Stamford, Conn.

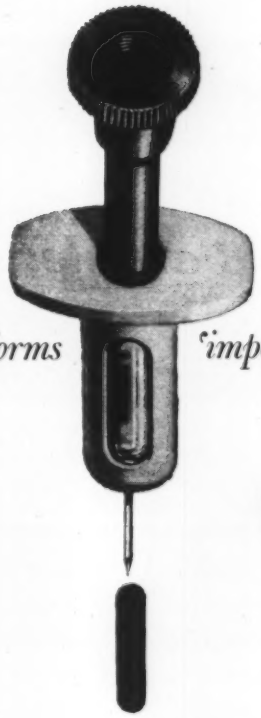
Circle 488 on page 19

Weight Slide Rule

calculates weight of metals from dimensions

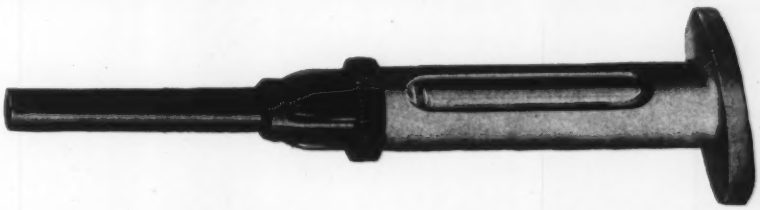
Slide rule gives weight of various geometric shapes in aluminum, cast iron, steel, brass, copper, and lead. Shapes include round, square, hexagon, hollow cylinder, sphere, wedge, cone, and irregular objects. Dimensions may also be determined when the weight is known. Constructed of aluminum, the slide rule is full size and is anodized with black graduations. **American Pattern**, 772 Bryant St., San Francisco 7, Calif.

Circle 489 on page 19



NOSCO 'CAN DO'

transforms 'impossible' parts into another everyday molding job



A noted pharmaceutical company asked us to develop an expendable hypodermic syringe that would remain completely sterile until use. Nosco engineers put their heads together . . . and came up with the answer pictured above! It looks simple—but here are a few of the tricky design problems involved.

There were dissimilar female threads at the ends of the combination needle guard and plunger . . . so we matched the pitch of these threads to enable the part to unscrew and eject as our mold is opening.

The syringe flange must be rigid to resist finger pressure when the hypo is administered, but it must also be undercut to hold the vial firmly in place. So, together with a material supplier, we developed a filled polyethylene to satisfy this part. And we solved the difficult task of removing the core pins from the syringe through the narrower top opening, by using floating pins temporarily held firm when the mold is first opened.

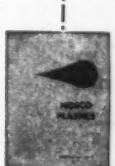
Despite these technical problems, the first volume order of Nosco-molded syringes were delivered to our customer on schedule.

Like our pharmaceutical customer, you'll be pleasantly surprised when Nosco "Can Do" goes to work for you! Let one of our sales-engineers start Nosco "Can Do" designing your next plastic part.

NOSCO plastics, inc. • erie 2, pa.

World's largest injection molding plant

For other case histories—and a glimpse of the Nosco plant and facilities, send for the free 12-page brochure.



Nosco Plastics, Inc., Erie 2, Pa. Send . . . copies of brochure: "How the Nosco Plant Works to Produce Your Needs in Practical Plastics."

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CITY _____ STATE _____

Circle 622 on page 19

PROFESSIONAL VIEWPOINTS

. . . a series of opinions aroused by Machine Design's March 8 article:

What's the answer to THE ENGINEER'S PROBLEM?

Unionism? Professionalism? Or both at the same time?

This subject is like religion and politics. They are all good topics for debate.

There are no pat answers. This article proposes none. But it does provide

1. A reflective appraisal of the current attitudes and feelings of many engineers
2. A cold analysis of the roles and objectives of engineers and their managements
3. A series of recommended actions and policies that can mutually benefit all parties

By Philip R. Marvin
Consultant
American Viscose Corp.
Philadelphia

. . . supply and demand . . .

To the Editor:

I most certainly advocate professionalism, rather than unionism. I believe that each one of us, whether doctor, writer, engineer, or factory worker, has a commodity to sell—our services—which can only find a market as a result of our ability to add value to a product or an enterprise.

The return on our investment, which is the time an individual has spent learning a profession or trade, should be based on our ability to apply the knowledge we have to our particular venture, with the results of that application showing up in productivity or increased value.

American industry and the American standard of living have reached their present high level due to the initiative and the productivity of individuals rather than to the use of force or coercion due solely to numbers.

Of course, we must realize that services of individuals, just as the cost of a particular commodity, are regulated by supply and demand. Therefore a complete solution of the particular problem with regard to remuneration in a specific field, regardless of that field, can only be reached by a harmonious agreement between buyer and seller to the mutual benefit of both.

D. W. RETZINGER
Young Radiator Co.

. . . fair compensation . . .

To the Editor:

Mr. Marvin's article begins with the words, "The high standard of living in the United States has been made possible largely as a result of the efforts of the engineer."

This is, if anything, an understatement. Our material progress would have been impossible without engineering. Politicians, doctors, lawyers, salesmen, businessmen, and craftsmen were all here in the horse-and-buggy days, but the engineer was the catalyst that brought the modern age into being.

Yet, in spite of his pre-eminent contribution, the engineer has always been poorly paid by any standard of comparison. Recently I have read a number of articles proposing cures for the shortage of engineers. It has amazed me to note that not one has had the honesty or the courage to suggest higher salaries. Most of these articles have been thinly disguised attempts to head off any real improvement in the status of engineers. Even Mr. Marvin's article is tinged with this sort of insincerity for in closing he reiterates that the engineer must "do a better job on his present assignment." Now the engineer is doing as good a job as anybody else. If he has to "do a better job"—that is, work twice as hard to get his due—he is still just the underpaid sucker that Mr. Marvin evidently considers him to be when he thus digs in the spur.

Mr. Marvin declares that "the most valuable engineers are the ones who make the greatest contribution to the overall corporation profit picture." This is very true, but unfortunately there is usually no obvious and immediate correlation between an engineer's work and company profits. This fact puts the engineer at a disadvantage as compared to a salesman or a machine operator when it comes to evaluating his services, and gives management a convenient excuse for dodging the issue of fair compensation. It looks as though unionism is the regrettable

answer. In the union market, engineers would command twice what they are paid today.

—FRANCIS A. SNELL
Springfield, Vt.

. . . a goal for engineers . . .

To the Editor:

It's a rare day when one meets an effective manager who yearns to be an engineer. On the other hand, it's even more rare to meet an engineer who doesn't dream and strive to become a manager. I submit that each type of endeavor requires its particular combination of skills and personality structure. Both types of endeavor are necessary to modern industrial organizations, one no more than the other.

It seems to me that the continuing shortage of engineers can be alleviated not by "promotion" of the skillful engineer to managership, thus reducing the corps of engineers, but by establishing an equivalent goal for engineers. This goal would have prestige equal to that of managership, but would require the exercise of engineering skills to achieve and maintain it.

Conceivably, there could be found in this country a group of objective people from both engineering and management who could brainstorm the creation of this goal in a relatively short time. They could emerge with a sound and healthy concept of an engineer's goal to match that sought by the manager. Thereafter, with appropriate publicity and the passing of time, the problem, which in fact belongs to both the engineer and the manager, would cease to exist.

—R. G. MUNROE
Raytheon Mfg. Co.

. . . simple problem, simple solution . . .

To the Editor:

It is almost axiomatic that no one, whether individual or corporation, can hold back a truly responsible, creative individual. If

(*Continued on Page 220*)

Westinghouse pilot plant for precision castings speeds development, saves capital investment

Proving ground for castings

Now . . . without heavy capital investment . . . you can prove your ideas and developmental work for molded metal products.

Modern pilot plant facilities are available at the new Westinghouse metals plant, Blairsville, Pa., to help you explore full production conditions and create prototype quantities. Here you can compare conveniently all types of castings at one place from the same heat.

Open production capacity is also available for fast, dependable delivery on precision investment castings (lost wax process), shell-mold castings and powder metal parts.

In making a value analysis of your product components, consider molded metal parts for pieces involving intricate shapes, close tolerances, difficult machining operations or component assemblies. You save machining, improve finishes, reduce rejections.

Send today for further details and a copy of DB 52-500. Also enclose a photo, drawing or sample of the part you want evaluated. No obligation. Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-05001

WATCH WESTINGHOUSE!

*WHERE **BIG** THINGS ARE HAPPENING **TODAY!***

Circle 623 on page 19

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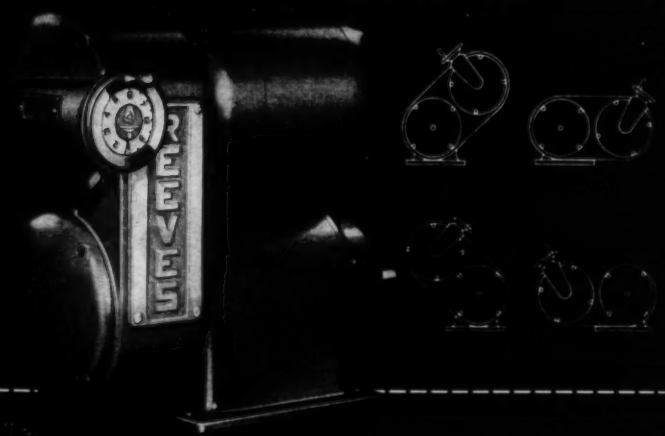
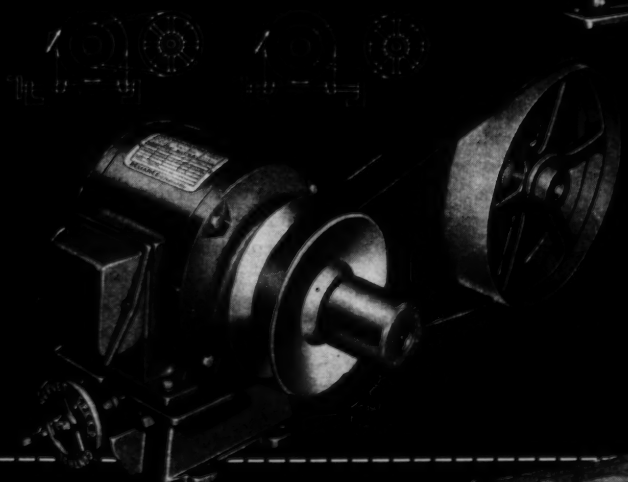
the one name for all mechanical variable speed!

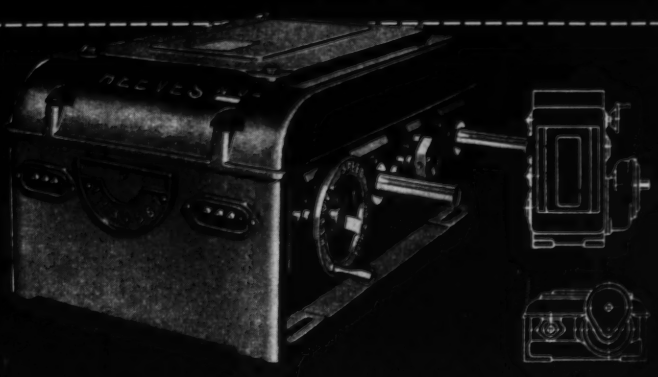
REEVES
Vari-Speed®
Motodrive





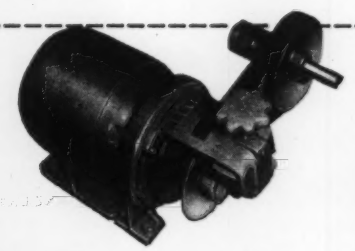
REEVES
Vari-Speed®
Motor Pulley

REEVES
Variable Speed
Transmission



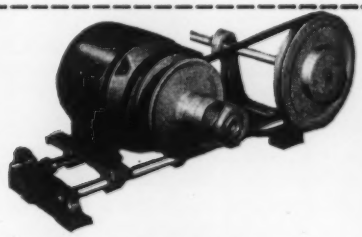
● The *complete line* in the industry is REEVES . . . adjustable speed drives and speed control for applications from ⅛ to 87 hp! The *proven* name is REEVES . . . years of trouble-free service in hundreds of thousands of installations—every industry! The *original* variable speed drive, REEVES is still the leader in its field!

Incorporate variable speed into the machines *you* design: widen the work range of the machines; insure your designs against early obsolescence; add the many operating advantages of accurate, instant speed control. Your REEVES representative—with wide and varied experience—will be glad to work with you for the *best* application . . . *best* results!



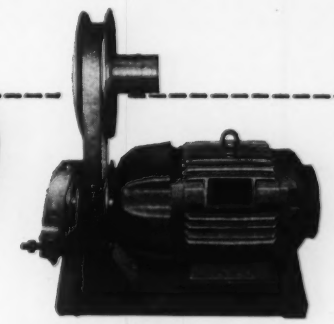
REEVES Flexi-Speed®

Two sets of adjustable discs with convenient shifting mechanism. Provides flexibility, economy to your equipment . . . easy to install. ½, ¾ and 1 hp. with 8:1 speed ratio.



REEVES Jr. Motor Pulley

Simplest form of variable speed control. 5 sizes from ⅛ to 1½ hp. capacity . . . ratios up to 2.75:1 in a speed range from 135 to 1965 rpm. Standard or countershaft bases for standard motors.



REEVES Vari-Spin®

A mill tested and proved unit to increase spinning efficiency and frame flexibility. 500 to 1450 rpm. range. Change speeds *with spinning frame in operation* . . . get required speed—in seconds!

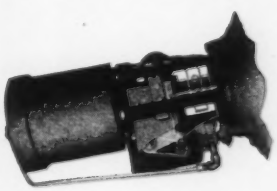
REEVES CONTROLS

Manual

Basic REEVES control on all units. "Speedial" handwheel, extended handwheel, hand chain and extended rod controls also available.

***Mechanical Automatic**

For Motodrive, Transmission. Simplest automatic control—requires shifting force sufficient to position control lever of speed changing mechanism.



Automatic (Pneumatic)

Motodrive application only. Cam-compensated design controls output speeds in direct proportion to instrument air signals.

Electric Remote

Push-button stations for single unit or battery of Motodrives, Transmissions or Motor Pulleys. AC or DC . . . full range of current characteristics.

*Also available in hydraulic or pneumatic type.

Individual bulletins—complete with rating tables and dimensions—are available for any of the above products by writing REEVES, Dept. H-26, Columbus, Indiana.

Your REEVES representative will be glad to work directly with you. He's as near as your telephone . . . regional offices in 34 principal cities.

REEVES PULLEY COMPANY

DIVISION OF **RELIANCE** ELECTRIC AND ENGINEERING CO.

COLUMBUS, INDIANA

Circle 624 on page 19

VIBREX

LOCKS - SEALS - CUSHIONS

mounts in a plain hole
no receiver unit
no rivets
no grommets
no springs

Vibrex is a sturdy half-turn fastener It is also an elastic joint, a shock and rattle isolator, and a moistureproof seal.

Simpler to install than other fasteners, Vibrex cushions the entire panel-base assembly in *live, resilient* rubber, squelching rattles, noise and vibration Vibrex Fasteners will not harm enamelled finishes.

Vibrex Fasteners are ideally suited for securing metal or plastic components — applications are innumerable for appliances, electrical panels, housings, and access doors. Produced in a wide range of sizes and types, Vibrex Fasteners are manufactured in the U.S.A., England and France. Write to Dept M for samples and catalog today

VIBREX FASTENER CORPORATION
MOUNT KISCO N. Y.

Circle 625 on page 19

Professional Viewpoints

(*Continued from page* 217)

there are any complaints in this regard, they can usually be resolved within oneself as justifying a temerity, or a hidden belief of one's essential ignorance. However learned a man might be, it is not difficult to imagine a man more learned—but there is a very deep chasm between education and wisdom. The engineer of wisdom is a man indeed! It is not to a corporation's advantage to shackle unduly a responsible engineer. If anyone does so, it is not the "corporation," but individual power politics at work. And the engineer so shackled need not remain in such a predicament; an intelligent man will discover a dozen alternatives. Time and effort wasted in crying about a situation will only bring bitterness into the individual's life, and bitterness eventually bears bitter fruit.

Perhaps I have over-simplified —but then the problem may be as simple as the solution. We can ask ourselves: Why did I choose to be an engineer? And then: Am I accomplishing my basic purpose? If the answer to the second question is "Yes," we can relax. Time is on our side!

—WALDO T. BOYD
Solar Aircraft Co.

. . . a sense of vocation . . .

To the Editor:

There are a few points on which I would agree with Mr. Marvin, two in particular. First, I agree that he has presented no pat answers. Then, too, I would agree that his is a good topic for debate. Unfortunately, however, Mr. Marvin, like so many people who debate religion and politics, has no clear-cut idea of what he is debating and expends his efforts on the periphery of any real problem.

The article, subtitled "Unionism? Professionalism?" somehow seems to deal with the problem of how to be successful or, to put it bluntly as does the author, "how to make money and to achieve recognition." His problem, then, is not really an engineer's problem,

Through the years, our trade mark has become a mark of quality that stands for the simplicity, efficiency and dependability of Curtis Universal Joints . . . the Hallmark of the industry.

In a wide range of applications, Curtis Joints offer the designer assurance of long life and trouble-free performance — because they are quality-controlled at each step of manufacture.

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- 14 sizes always in stock 3/8" to 4" O.D.
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Our catalog torque and load ratings are substantiated by constant tests. You can depend on them.

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As near to you as your telephone

A MANUFACTURER OF
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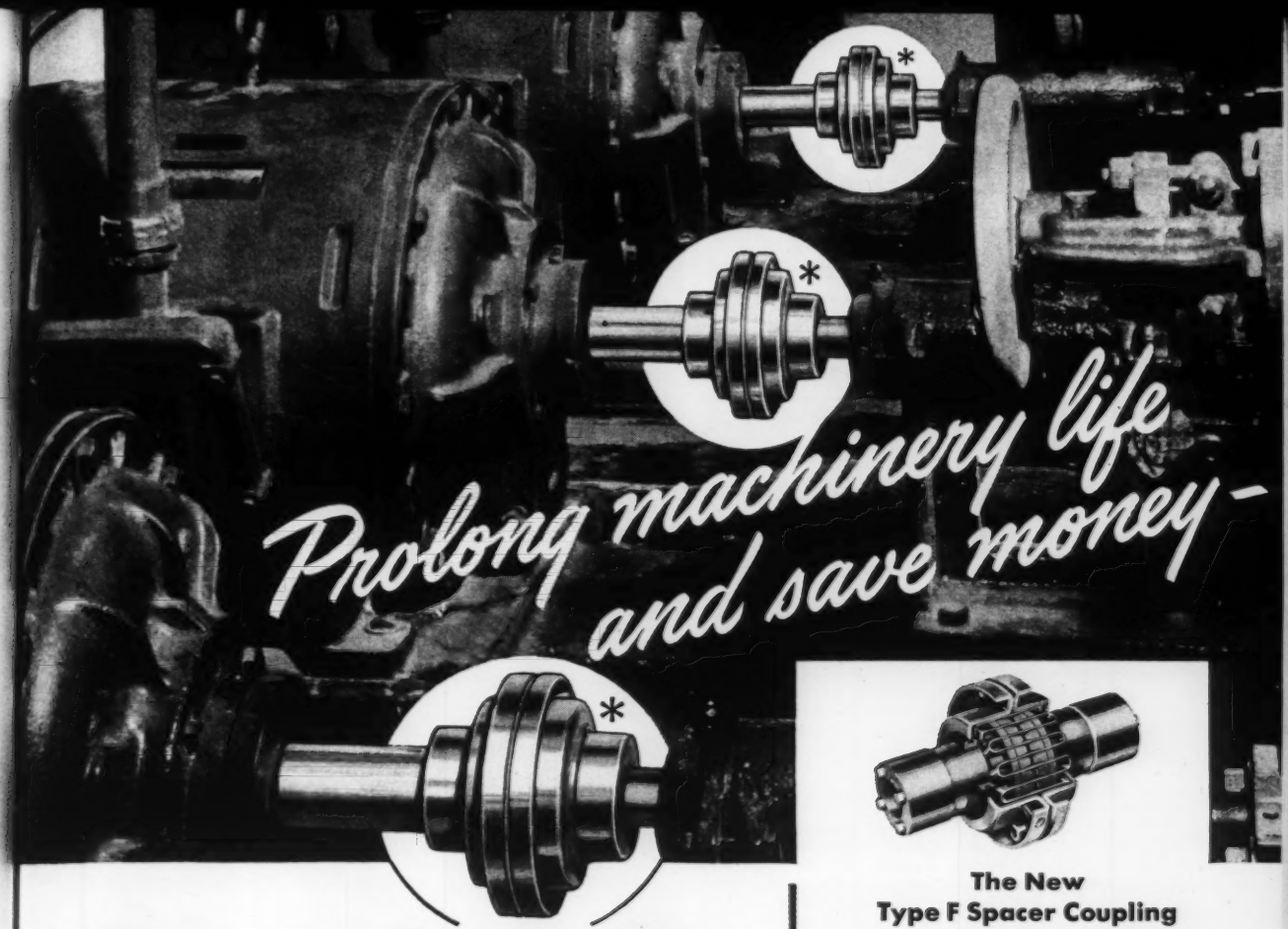
Circle 626 on page 19



with FALK Steelflex Couplings

Ever since the first Falk Steelflex Coupling was designed and built, we have firmly held to these beliefs:

1. A coupling, to give fullest value, must do more than merely *connect* driving and driven machinery—it must *protect* the machinery and prolong its life.

2. A coupling, to be truly flexible, must overcome the effects of shock and vibration, as well as shaft misalignment.

Proof of the soundness of those beliefs is furnished by the record. More than one million Falk Steelflex Couplings have been used on every conceivable type of industrial application . . . giving trouble-free service, providing maximum protection to connected machinery.

* A single basic type—the famous Type F—fills 90% of all industrial application needs. It is versatile, efficient and economical. And—it is always available from factory, field or distributor stocks, in a wide range of sizes.

Write to Department 247 for engineering bulletin, including selection and dimension tables.

THE FALK CORPORATION, MILWAUKEE, WISCONSIN

MANUFACTURERS OF:

- Motoreducers
- Speed Reducers
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- Single Helical Gears
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- Marine Drives
- Steel Castings
- Weldments
- Contract Machining

FALK

...a good name in industry

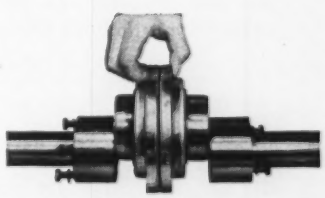
Circle 627 on page 19

The New Type F Spacer Coupling

Here is a Steelflex coupling specially designed to permit fast, easy installation and removal in horizontal and vertical applications where it is impracticable to move the connected units—or where a space-gap (up to 12 in.) is necessary.

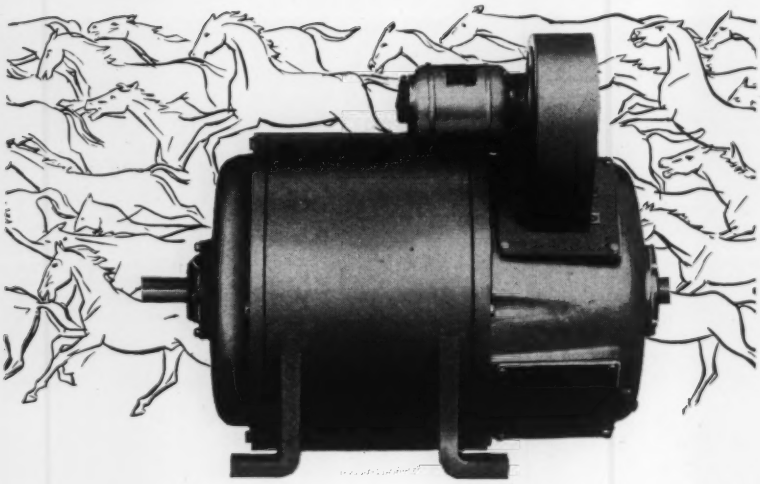
Like all Steelflex couplings, the Type F Spacer gives long, trouble-free service and maximum 3-way protection for connected machinery: it provides torsional resilience to reduce shock and vibration; it accommodates parallel or angular shaft misalignment; it allows free (or limited) end float.

An outstanding feature of the Steelflex Spacer is that it can be installed or removed in one piece (see photo below); no dismantling or servicing of the coupling is required. Pump assemblies can be disconnected and removed without disassembling the coupling, without exposing working parts.



The Steelflex Spacer coupling is prelubricated at the Factory and can be installed, or removed and reinstalled, without disturbing the lubricant—a highly desirable feature.

SPECIAL



five equals fifty

This DC motor is actually ten times the motor it appears to be. It is the size of a 5-h.p. motor, but it's rated 50 h.p. short-duty, and over 20 h.p. continuous.

In designing this particular shunt-wound motor, high power in a small space was the major consideration, but not the only one. It also had to accelerate to 6000 r.p.m. within one second and withstand frequent, fast reversals without excessive overheating. Physically, this small-scale giant measures just 16" long by 9½" dia., and weighs only 115 lbs.

Admittedly, this is a special motor. It is also typical of ESCO's unusual ability to design and build all kinds of special rotary equipment to meet particular needs. For over forty years ESCO has been pleasing its customers by finding answers that exactly match special requirements. Perhaps our solution to your particular motor problem will please you, too.

Refer to Esco Catalog in section 4a/E1 in Sweet's Product Design File, or write direct for general catalog No. 56PD. Why not also send us details on your special problem — we'll be glad to show you how we would go about solving it for you.

ESCO ELECTRIC SPECIALTY CO.
179 South Street, Stamford, Conn.

Circle 628 on page 19

but that of a great many people. His solution is also generally applicable. The successful individual carefully chooses his means, does a little more than is expected of him, and avoids any mistakes in judgment which may be costly and time-consuming. And there you are! Or are you?

These same great many people who, today, are trying to solve their problems in this fashion have made the end the means. Their work is the means of forging ahead to the end beyond which lie increased rewards, both financial and prestigewise. The way, however, is frequently paved with ulcers and mental hospitals.

Now then, it seems to me that Mr. Marvin's approach to whatever his problem is indicates a lack of courage to face his real problems. He, of course, is not unique in this respect, for all of us do the same thing and thus we have a multiplicity of imaginary or semireal problems to occupy our thoughts. Do we want to be professional, or is the real question one of why work at all? Do we work because we want to forge ahead, or should it somehow be related to the very nature of our existence? Are we engineers, or doctors, because it is profitable, or is there a sense of vocation required? Should a man come home complaining at the slowness of his professional recognition, or can he feel at the end of each day that he has done his best, that he has made some contribution to the common good? These are some of the real questions we should be asking, and they require difficult and profound thinking for whatever answers might be forthcoming.

I feel that an entirely new—and probably unpopular—approach can and must be taken before very much can be accomplished. A great many of the stock definitions and phrases must be discarded. The exclusive professional attitude must be discarded, and most important, the typical Chamber of Commerce approach of more, bigger and better—usually in terms of money or numbers—must be discarded.

The starting point for this new

GRC DIE CASTS MOVABLE PARTS IN ONE UNIT, RESULTING IN BETTER DESIGN, LOWER COST

This GRC "Intercast" swivel ring on left cast —this assembled complete in single operation. Ring on right required assembly of two screw machine parts plus a metal stamping.

Intercast, exclusive GRC cast-assembly process produces single units or continuously interlocked assemblies, ready for use.

Previously, Metalcraft Corp., leading manufacturer of picture frames needed *two screw machine parts, a metal stamping plus two assembly operations* to complete their picture frame swivel rings. With Gries "Intercast" production, *a single automatic operation casts the unit completely* assembled, trimmed, *and ready for use.* Metalcraft eliminated assembly entirely, *effected economies of over 50%* and received a more attractive component.

"Intercast" is only one of the exclusive Gries die-casting techniques and processes that offer industry drastic reductions in production costs and new opportunities for improved design. Unique GRC machines turn out simple or intricate small parts, complete, in one high-speed automatic operation. Many manufacturers have found that Gries facilities give them a better product while reducing costs and eliminating machining and assembly operations.

Gries small zinc alloy die cast parts are made to fit size, shape and tolerance specifications *precisely*. Smallness is unlimited (maximum weight ½ ounce, maximum length 1¾ inches). All are mass-produced at low cost in quantities of 100,000 to many millions.

Send for further information on "Intercast" and other Gries small-parts production facilities, and find out how they can be applied to your particular problems.

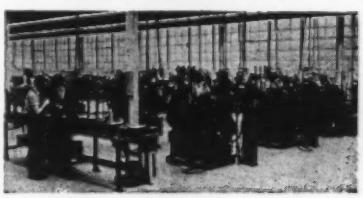
Wide Variety of Stock Parts Available from Gries

Zinc-alloy and plastic molded products and components covering hundreds of industries can be obtained from GRC. Industrial fasteners such as wing nuts and cap nuts, are produced in great volume, along with saddlery, awning, drapery and window hardware items, nylon coil bobbins, washers and valve seats; die-cast gears and pinions in hundreds of standard combinations. Many other specific parts available; write for full information today.

GRC Gives Help on Design and Production Problems

To learn how designs can be simplified and assembly operations reduced or eliminated, write for useful reference copy of Gries' fact-filled bulletin. In addition, Gries' staff is available to manufacturers for personal consultation on design and production of GRC automatically die-cast and plastic-molded small parts.

GRC Offers Extensive Facilities



In the modern Gries plant, complete production facilities for small precision parts, plus a highly qualified engineering staff, guarantee the manufacture of even the tiniest, most intricate components to exact specifications. In addition to complete production tooling and design development, comprehensive facilities are available for secondary operations . . . machining, tapping, threading, assembly, etc. Practically all commercial finishes can be applied in the complete Gries plating department.

WORLD'S FOREMOST PRODUCER OF SMALL DIE CASTINGS

GRIES

GRIES REPRODUCER CORP.

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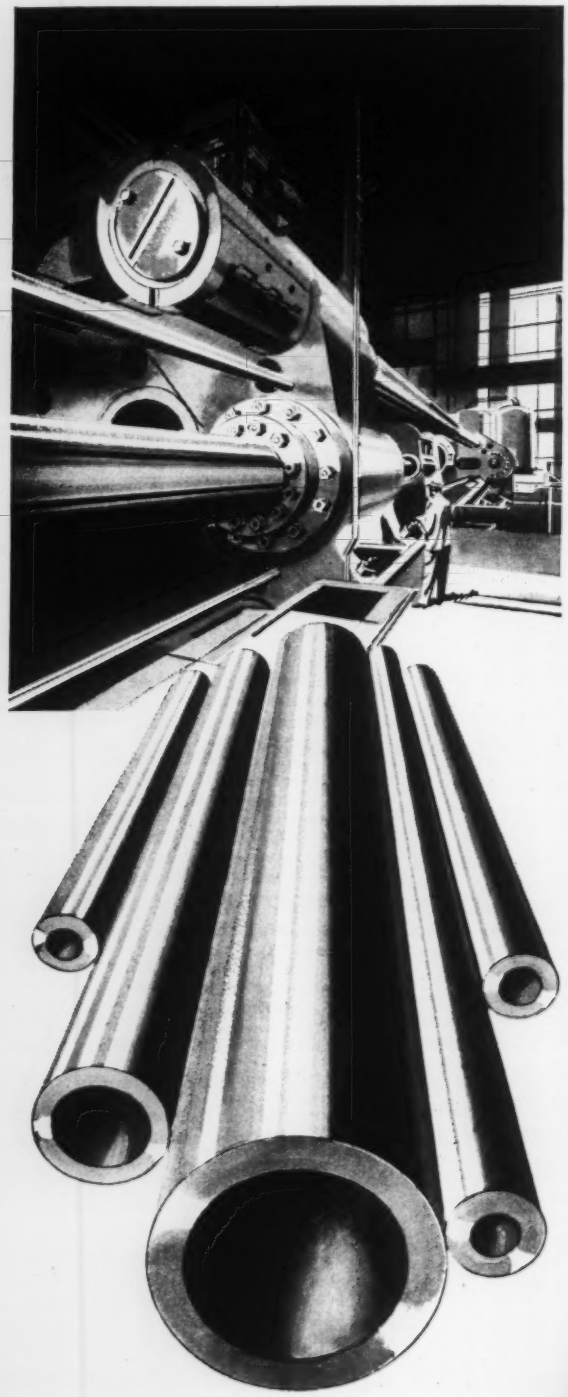
NOW! from the world's largest horizontal steel extrusion press...



SEAMLESS

HEAVY WALL PIPE

from any ferrous alloy

Now heavy wall pipe can be extruded from any ferrous alloy — in lengths up to 50 feet or more, with O.D.'s from 4″ to 22″, and with virtually no restriction on wall thickness.

The giant Curtiss-Wright horizontal extrusion press, now operating at the Metals Processing Division, *moves* the metal instead of *removing* it, for pipe of maximum length — and strength.

If your application calls for higher heat, corrosion and/or abrasion resistance — in pipe of highest tensile and yield strengths — Metals Processing Division is geared to fill the requirement. Complete facilities for handling any ferrous alloy, including the stainless series, as well as titanium and other reactive metals, are available to the chemical, petroleum, power and other key industries.

Take advantage of this new, aggressive facility for your pipe requirements. Write, wire or telephone for detailed information or engineering consultation today. Our field engineers are at your service.

METALS PROCESSING DIVISION

CURTISS-WRIGHT

CORPORATION • BUFFALO, NEW YORK

71 Grider Street, Buffalo, New York

Circle 630 on page 19

approach must be a deep sense of vocation. With this as a beginning, one is then able to show that the questions of professionalism, business ethics and motivation, almost always treated as separate subjects, have a common root and are subject to a single analysis.

Such a beginning will not solve the average person's day-to-day problems, but it will expose them to the proper perspective and enable the person, at least, to ask the proper questions and recognize a problem when he sees one.

—WILLIAM R. SHAFFER
John R. Wald Co.

. . . attitude counts . . .

To the Editor:

It is true that engineer training, while a most important step in solving the problem, is not a solution in itself. The constructive approach to the problem is rather a broader one of attitude—the mutual desire for intelligent understanding, a sincere regard for human values and feelings, and an honest searching for higher life values.

J. D. Lovely of Chrysler Airtemp said in a recent survey by the NSPE, "Training is really just a state of mind. Basically it is nothing more than creating an environment which will encourage the young engineer to strive for fulfillment, and then stimulate him to go ahead and develop himself professionally." Training itself is not a panacea; it is the attitude that counts.

It is true that most of the engineers' goals, other than the purely professional ones, are those of most all workers. However, the engineers' goals deserve the limelight today for two reasons: first, the personal needs of hourly workers, who constitute the majority, have been brought to recognition through various forces exerted by labor, and have in reasonable measure been cared for; thus the remainder, the white-collar workers, are overdue attention in this regard. Secondly, of the white-collar group, engineers come to the fore because the skyrocket-

(*Concluded on Page* 228)

design for riveting . . . "the *Tubular* way"

Here is how to apply "The ***Tubular*** Way" of modern riveting to your fastening problems. It can help get the answers *you* need for *better* fastening . . . in less time and without trouble.

1. Choose the *right* rivet for your particular job — semi-tubular, full tubular, split, or a "special." Specify the *right* metal for adequate strength or special properties. Consider the need for plating or a special finish.

2. Determine rivet location. Allow sufficient clearance for setting. Figure work-hole and clinch allowances. Examine possibility of setting several rivets at a time on different planes if necessary. Ask about ***Tubular's*** machines for doing this.

3. See if one rivet can do more than one job — such as fastening and performing hinge, bearing or contact functions. ***Tubular's*** PERMA-NUTS economically combine both rivet and threaded fastener features.

Before you "freeze" your design . . . talk to ***Tubular***. We can help you here with every requirement mentioned. We can do it to your best advantage at the design stage. We will be glad to recommend the right rivet and the right machine for the fastest, most economical setting method.

Design for riveting "The ***Tubular*** Way."
Send prints and/or sample work for technical help.
No obligation. Data on request.

Tubular Rivet & Stud Company

WOLLASTON (QUINCY) 70, MASS.

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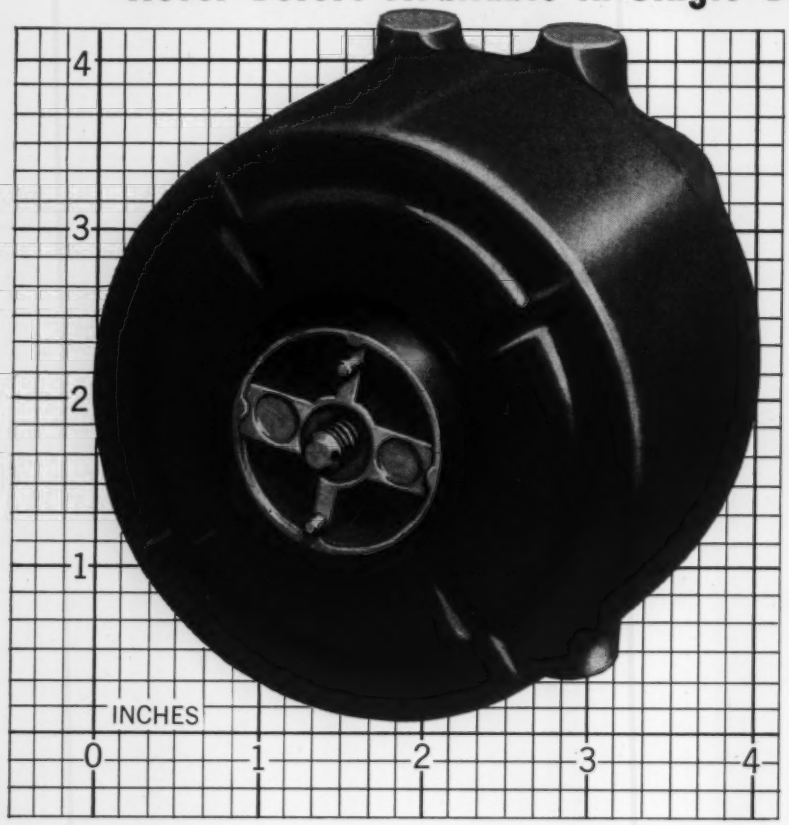
See your local classified directory for phone numbers.

Circle 631 on page 19

(Advertisement)

ELECTRIC MOTOR DESIGN NEWS

New Redmond FHP MonoMotor Incorporates Design Features Never Before Available in Single-Bearing Motors



The new AM-4 has two design features that are available for the first time in a single-bearing small diameter motor. Redmond's patented Tri-Flux design, described at the bottom of this page, adds a third area of magnetic flux, greatly increasing efficiency and starting and running torques over conventional motors. Uni-Cast Construction provides quality through the rigidity and close tolerances characteristic of this design.

2-Year Warranty, All-Angle Operation, Controlled End Play, and Lifetime Lubrication Are Other Features

With the new positive oil system that is used in the AM-4, an extra large oil reservoir is permanently sealed for lifetime lubrication and is guaranteed not to leak oil in use or shipment. A special thrust arrangement accurately controls end play. Designed for all-position mounting—vertical shaft up, shaft down, or any angle—the AM-4 is adaptable to a wide variety of applications.

A rugged, yet smooth, whisper-quiet motor that will give outstanding performance over years of service-free use, the AM-4 is backed by Redmond's full two-year warranty.

Descriptive Brochure Available

For the complete story on the new AM-4—dimensions, performance, operational data, and suggested applications—write the Redmond Co., Owosso, Michigan, for the "AM-4 Bulletin."

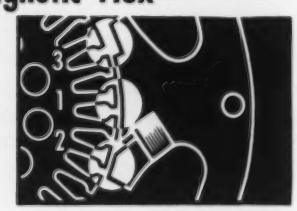
Designed Specifically for Refrigeration and Air Conditioning Industries, New AM-4 Is Adaptable for a Wide Variety of Applications

The basic type AM-4 is a 4-pole motor, 1550 r.p.m., 115 volts, 60 cycles. It is available in odd voltages and frequencies and is rated at 1½, 4, 6, 9, 12 and 16 watts. The shaft is 5/16" in diameter. There are six lead outlets.

How Tri-Flux Design Adds Third Area of Magnetic Flux

The salient pole single phase induction motor has only one flux path—indicated by the white circle—between the field and the rotor. The motor is not self-starting—for commercial value a starting mechanism must be added.

The second white circle indicates the flux path added by wrapping a shading coil around the trailing pole tip. Power and uni-directional action are increased in this shaded pole induction motor, and it is now self-starting. This motor is now practical at low cost, and is used for applications requiring limited starting torque.



Note that a third flux path has been added at the leading pole tip. This was accomplished by Redmond's Tri-Flux design, whereby a "reluctance notch," which can be seen in the third white circle, is put in the leading pole tip. Efficiency and starting and running torques are greatly increased. New applications are opened to these improved, low-cost motors.

Your prime source for

TITANIUM
FASTENERS

VOI-SHAN Titanium fasteners are available in all configurations. The company's long record of *prompt service* and *guaranteed quality* is your assurance of complete satisfaction.

Send for your copy of: "VOI-SHAN Reports on Titanium."

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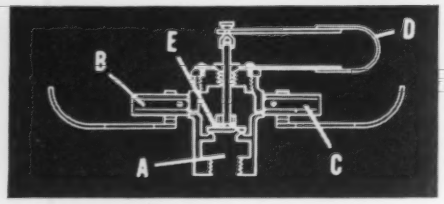
Circle 633 on page 19

HOW CHACE THERMOSTATIC BIMETAL ACTUATES THE

EverHot AUTOMATIC **GAS PILOT**

A Product of
EverHot Heater Co.
Detroit, Mich.



Modern living calls for more hot water—more often—what with frequent bathing, automatic dishwashers, home laundries, etc. But modern living also demands safety—and the EverHot Deluxe Gas Automatic Water Heater, whose pilot is actuated by Chace Thermostatic Bimetal, provides economy, efficiency *and* safety in good measure.

This device combines the functions of burner and pilot jets. The flow for the burner heat is controlled by the temperature of the water in the tank through the main gas inlet (A). The heat of the gas pilots at (B) and (C) causes the bimetal element (D) to flex upward, raising the valve (E) from the valve seat, and the valve will remain open as long as the pilot lights burn. Should the pilot light be extinguished, the element will cool and the bimetal element will assume its normal position, lowering the valve to its seat and cutting off the main flow of gas.

Chace Thermostatic Bimetal is available in 28 types, in strip, coil or completely fabricated and assembled elements made to your specification. Write for new 44-page booklet, "Successful Applications of Chace Thermostatic Bimetal," containing interesting uses of bimetal, formulas, calculations, etc.

W. M. CHACE CO.
Thermostatic Bimetal
1616 BEARD AVE., DETROIT 9, MICH.

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Professional Viewpoints

(*Concluded from Page* 225)

ing technology of the last few decades has created such a need that thinking management—and this includes engineers since they are a part of management—is induced to soul-search for most effective methods of utilizing professional talent.

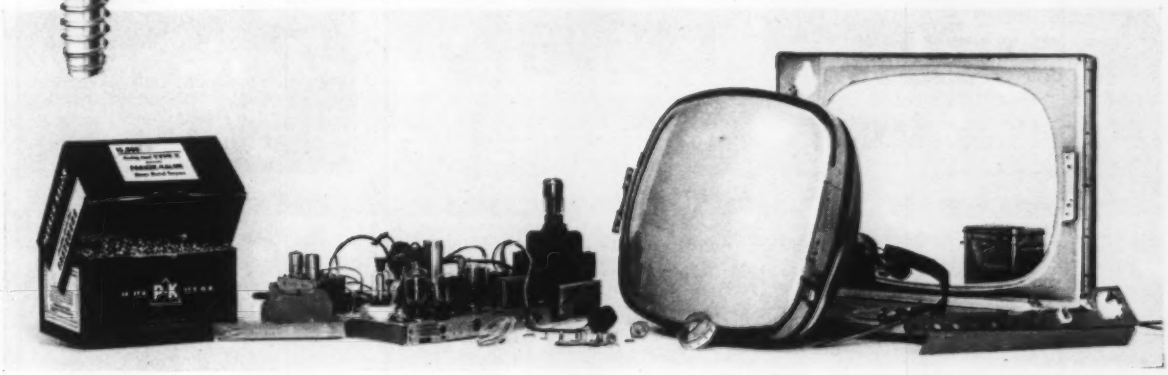
The writer's personal opinion would place a difference of degree or emphasis between the goals of professional and those of nonprofessional people. For those of scientific bent, the technical subject material and job content have high motivating power and therefore assume near-top priority. Although engineers talk a great deal about salary because this is a popular topic, it actually takes a distinctly subordinate position in their thinking compared with the consideration of having interesting subject material on which to work.

Most commendable, I think, in Mr. Marvin's paper is the stimulating motivation to not just management or supervisors alone, but to all engineers to contribute willingly their share in this all-important problem solution.

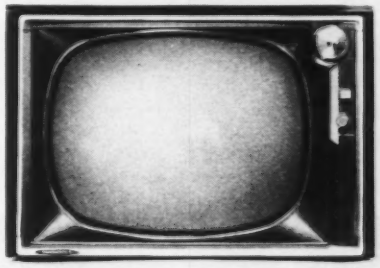
—W. L. EDDY
Kellogg Switchboard & Supply Co.

"You wanted the machine to take up a minimum of floor space."

P-K® screws help Motorola



put together assembly savings



How designers and production men work hand in hand to keep production up . . . assembly costs down

To keep production high and costs low, Motorola designers specify the best fasteners that can be bought—Parker-Kalon Self-tapping Screws. They know that *the price paid for fasteners is but a small fraction of the cost of using those fasteners in production.* Because P-K Self-tapping Screws consistently start right . . . drive right . . . and stay tight, Motorola guards against assembly slowdowns and costly salvaging of damaged parts.

This example is typical of thousands of cases where designers help production men turn out a better product *faster*—and at less cost—by specifying P-K Self-tapping Screws. This simple fact is being proved day after day . . . "if it's P-K, it's O.K."

PARKER-KALON DIVISION, General American Transportation Corporation

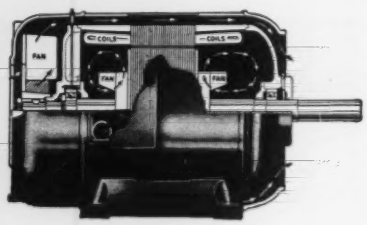
PARKER-KALON®
fasteners

Sold Everywhere Through Leading Industrial Distributors

Factory: Clifton, New Jersey—Warehouses: Chicago, Illinois—Los Angeles, California

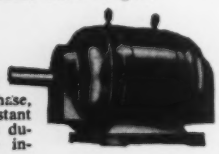
ELECTRIC
POWER
AT IT'S MONEY SAVING
BEST . . !

AIR COOLED



VALLEY
BALL BEARING
MOTORS

This completely enclosed but... air cooled motor is of the latest design—no foreign matter can penetrate the windings. Its ball bearings and stator core are kept cool by 3 fans which transfer the heat to the frame and end bells — cooling the motor completely — and remember a cool motor runs longer.



Other Types of Valley Motors

Type SN polyphase, high torque, constant speed, continuous duty, squirrel cage induction.

Type AN single phase, constant speed, continuous duty, repulsion start, induction run.

Write for Descriptive Literature.

VALLEY
ELECTRIC CORPORATION
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Circle 636 on page 19

THE ENGINEER'S Library

Recent Books

Fundamentals of Vibration Analysis. *By N. O. Myklestad; 260 pages, 6 by 9 in., clothbound; published by McGraw-Hill Book Co. Inc., 330 West 42nd St., New York 36, N. Y.; available from* MACHINE DESIGN, *$6.50 postpaid.*

This book is planned as the text for a first course in its subject at graduate or undergraduate levels and in industrial training programs. The first half of the book deals with systems of more than one degree of freedom. Chapters are included on the application of generalized co-ordinates and tabular methods for finding natural frequencies.

♦

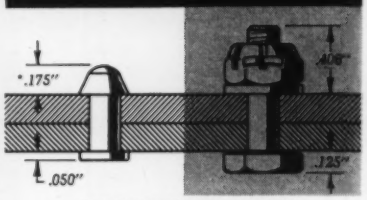
Transistor Electronics. *By Arthur W. Lo, Richard O. Endres, Jakob Zawels, Fred D. Waldhauer, and Chung-Chih Cheng, all of Electronics Products Div., R.C.A.; 520 pages, 6 by 9 in., clothbound; published by Prentice-Hall Inc., Englewood Cliffs, N. J.; available from* MACHINE DESIGN, *$12.00 postpaid.*

This book is written for advanced undergraduate or graduate students in electrical engineering and associated fields, and as a reference work for electronics engineers. Emphasis is placed on a basic understanding of the circuit aspects of the transistor. Chapters cover fundamental concepts of transistor physics, characteristics and general properties of transistors as circuits, high-frequency amplifiers, nonlinear operation of transistors, oscillators, modulation and demodulation, and pulse circuits.

♦

Cams—Design, Dynamics, and Accuracy. *By Harold A. Rothbart, mechanical engineering dept., City Col-*

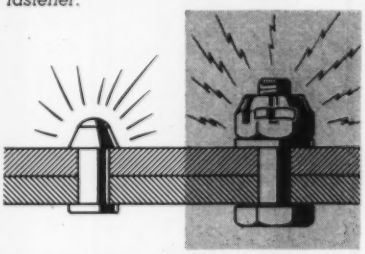
3 hi-shear FACTS THAT COUNT!



*PROTRUSION SHOWN FOR MAXIMUM GRIP CONDITION

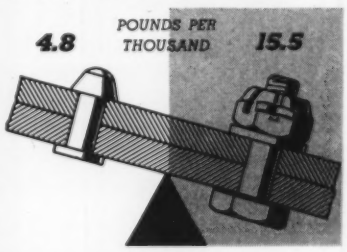
minimum protrusion

HI-SHEAR rivets have the smallest "headed ends" of any high strength fastener.



maximum smoothness

The smooth spherical rivet end eliminates chaffing of adjacent fuel cells or other equipment. HI-SHEARS eliminate hazards in aircraft areas which are accessible to the flight or maintenance crews, passengers and cargo.



less weight

HI-SHEAR rivets are the lightest, standard high strength fasteners in the aircraft industry.

Installed fastener size and weight shown above are based on HI-SHEAR HS52P-6-5 pin and HS15-6 collar compared to AN3-5 bolt, AN310-3 nut and AN960-10 washer.

write for our booklet

"Riveting with HI-SHEARS" for latest shop riveting methods.

U.S. and foreign patents— Trademark "HI-SHEAR" registered.

hi-shear RIVET TOOL COMPANY
2600 W. 247TH ST., TORRANCE, CALIF.

Circle 637 on page 19

Titanium Tubing

For processing lines carrying fluids of an extremely corrosive nature — look to *Contour Trentweld* titanium tubing for reliable service.

This titanium tubing is completely uniform throughout any cross-section. The weld zone is free from bulging weld bead because Trent's exclusive process — performed with the weld area at the bottom — forms the molten weld metal into the shape of the tubing.

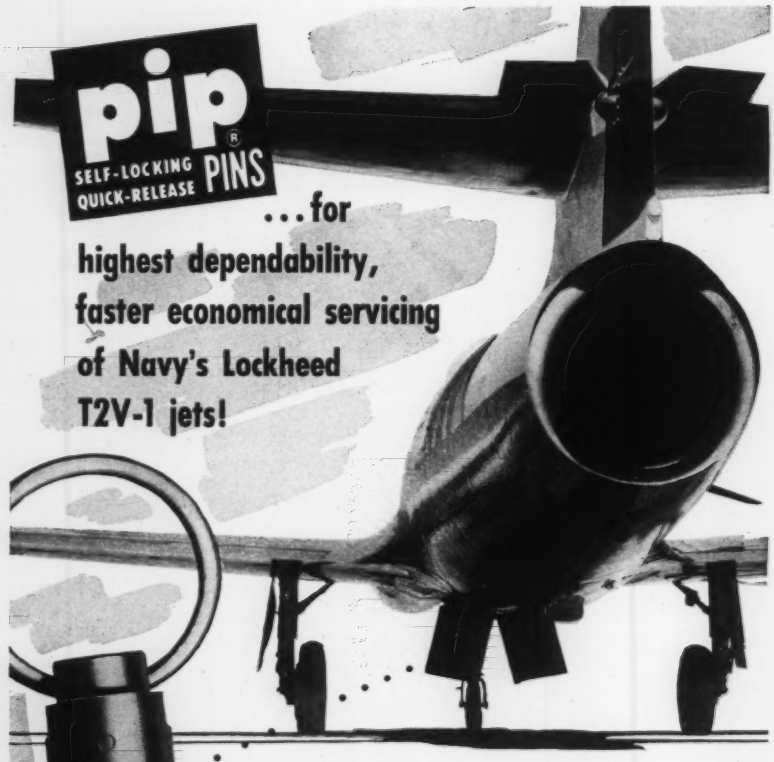
And, with titanium, you get the unique advantages of a tubing that's strong as steel but 44% lighter . . . virtually immune to a broad spectrum of corrosive materials . . . entirely free from stress-corrosion cracking.

So, next time you need a strong, light, extremely corrosion-resisting tubing—try *Contour Trentweld* titanium tubing. And remember, it's made by Trent — tube mill specialists.

CONTOUR TRENTWELD

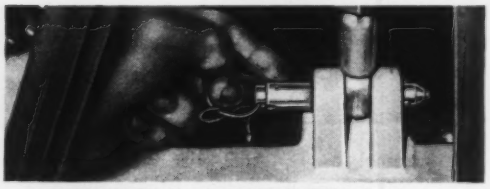
Stainless and High Alloy Welded Tubing

TRENT TUBE COMPANY, GENERAL SALES OFFICES, EAST TROY, WISCONSIN (Subsidiary of Crucible Steel Company of America)


pip
SELF-LOCKING QUICK-RELEASE PINS
...for highest dependability, faster economical servicing of Navy's Lockheed T2V-1 jets!

Dive flap attachment, servicing and interchangeability simplified with double-acting "B" type PIP Pins!

PIP Pin connection of hydraulic actuator to dive brake fitting answers Lockheed's design requirements for a safe, trouble-free lock pin capable of withstanding high shear loads and providing quick removal and interchangeability of the dive flap assembly without requiring nuts, washers, safety cotters, etc. In addition, PIP Pins offer drive-in drive-out features for easy insertion or removal when hole misalignment or normal structural variations bind the pin. A blow on the head or tip with a plastic mallet permits retaining balls to recede into body of pin as pin drifts in or out.



Model "B" PIP Pins in Lockheed's T2V-1 dive brake assembly take direct opening and retraction loads—give trouble-free operations. A pull on the heavy-duty continuous steel ring effects fast removal.

PIP—Reg. U. S. Pat. Off.
Patented

PIP pins are available in sizes to most bolt standards and in "T," "L," Ring and Button head styles.
For complete information write for Bulletin ADI-5500.

AVIATION DEVELOPMENTS INC.
210 SOUTH VICTORY BOULEVARD, BURBANK, CALIFORNIA

Burbank • Chicago • Denver • Fort Worth • Kansas City • London, England • New York • San Francisco • Seattle • Toronto, Canada • Wichita

Circle 639 on page 19

The Engineer's Library

lege of New York; 350 pages, 6 by 9 in., clothbound; published by John Wiley & Sons Inc., 440 Fourth Ave., New York 16, N. Y.; available from MACHINE DESIGN, *$9.50 postpaid.*

This book is directed primarily to machine designers and should be useful as well to students of mechanical engineering and instructors. The presentation emphasizes three aspects of cam design: the shape of the acceleration curve, flexibility and backlash, and accuracy of profile. Initial chapters cover basic curves, cam size and profile determination, additional cams and followers, and advanced curves. Later chapters cover polydyne cams, the dynamics of high-speed cam systems, force analysis, surface materials and accuracy, special cams and applications.

♦

Gas Turbines and Jet Propulsion, 6th Edition. *By G. Geoffrey Smith, revised by F. C. Sheffield. 412 pages, 5½ by 8½ in., clothbound; published by Philosophical Library Inc., 15 East 40th St., New York 16, N. Y.; available from* MACHINE DESIGN, *$15.00 postpaid.*

Initial chapters in this book treat the basic principles and history of jet propulsion. Several more chapters describe gas turbine components, fuels, fuel systems, metallurgical problems, research, testing and maintenance. Three chapters describe American, British and European turbines. Two chapters cover compounded units, ramjets, pulsejets and rockets. Concluding chapters cover applications of turbines other than in aircraft.

Manufacturers' Publications

Trane Refrigeration Manual. *133 pages, 8½ by 11 in., paper-covered wire-bound; published by and available from The Trane Co., LaCrosse, Wis.; $1.50 per copy.*

This manual describes equipment and processes for air conditioning and refrigeration. It is directed to contractors and tech-

nicians, and has been used in engineering instruction. The present third edition has been prepared to bring the contents up to date and to include new information on condenser fouling factors, motors and motor-control equipment, mufflers, piping arrangements and calculations of pipe sizes. New tables have been added to the chapter on thermoplastic expansion valves.

♦

A Manual of Processes for the Cold Bending of Metals and Abrasive Cut-Machining of Metals. *In part, by E. J. DeWitt and F. D. Alexander; 170 pages, 9 by 6 in., paper-covered ring-bound; published by and available from Wallace Supplies Mfg. Co., 1304 Diversey Parkway, Chicago 14, Ill.; $2.50 per copy.*

This reference book is directed to users of bending equipment and to designers who specify the bending of pipe and tubing. The book is divided into four main sections: the cold bending of metals, some considerations in the mold bending of tubular and structural shapes, why abrasive cut-off wheels sometimes fail, and the capabilities of abrasive cut-off machining.

♦

Graphic Presentation. *By Francis J. McHugh, cartographer, Naval War College; 14 pages, 6¼ by 9¾ in., paperbound; published by and available free of charge from Technifax Corp., 195 Appleton St., Holyoke, Mass.*

This booklet is directed to persons in the field of visual communication, particularly the communication of technical matter. It contains analyses of the basic types of visual presentations and recommendations for their application.

Government Publications

Performance Characteristics of Cushioning Materials Impacted Under a Heavy Weight High Impact Shock Machine, PB 121145. *By E. N. Sabbagh, Lowell Technological Insti-*

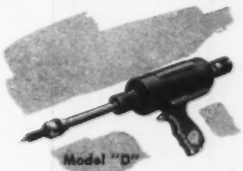
(Concluded on Page 236)

PRESS THE TRIGGER—

and Chobert® Automatic Riveting saves time—cuts material costs!

Photograph — North American Aviation, Inc.

North American Aviation Inc. use of Chobert system in blind application proves it!



Model "D"
Chobert Automatic Riveter.

An alert suggestion to replace stem and explosive type rivets with the Chobert Automatic Riveting System on a blind skin-to-frame joining operation saves North American Aviation 21.45 man minutes per unit. Poor uniformity with other rivets and time spent trimming and resetting are eliminated by using Chobert Blind Rivets—which cost, less too! A well known high-production riveting system in commercial fields, Chobert is recognized for outstanding results in the airframe industry.

Here's how the Chobert® Automatic Riveting System works!

The Chobert Blind Rivet has a tapered hollow shank through which a mandrel can be placed. This mandrel is loaded into a pneumatic riveting gun. The rivet, with the installed mandrel, is placed in the pre-drilled hole in the material. When the trigger on the pneumatic riveting gun is depressed, the mandrel is withdrawn through the rivet shank locking the rivet securely in place in the structure.

Let Chobert work and save for you now—get full details by writing for Chobert Automatic Riveting System brochure.

AVIATION DEVELOPMENTS INC. Chobert — Patented — Reg. U. S. Pat. Off.

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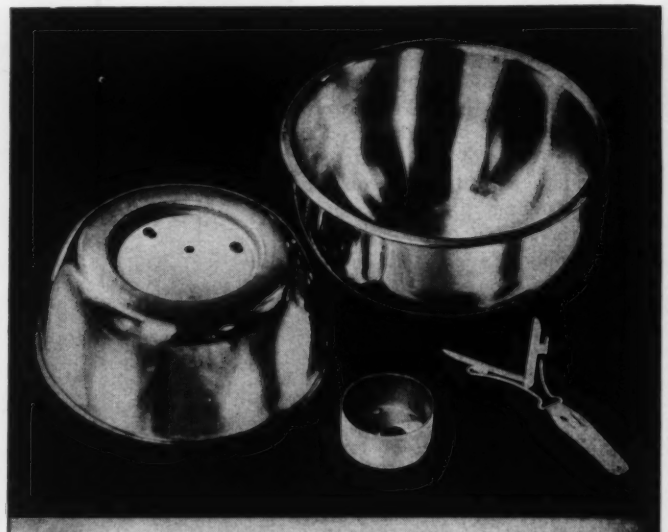
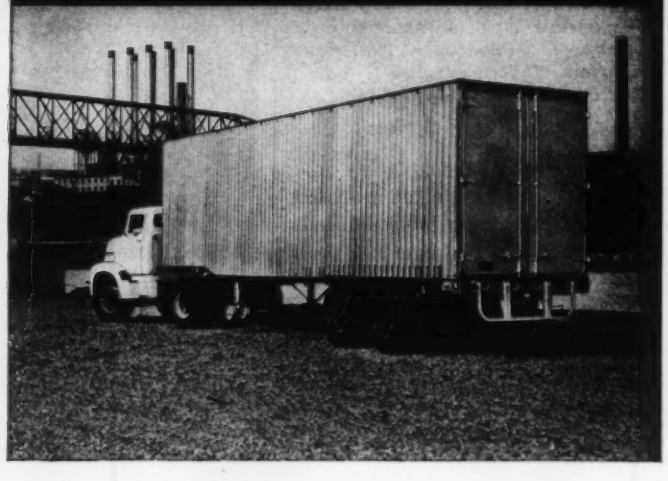
Circle 640 on page 19

You can draw and form them LITTLE



or fabricate them BIG



with the new A-L low-nickel STAINLESS GRADES

WRITE FOR THE ASSISTANCE YOU NEED

1. "TECHNICAL STUDIES #3"

. . . essential information on the composition, properties, fabricating methods and applications of AL chromium-manganese, low-nickel stainless steels. *Write for your copy.*

2. TEST SAMPLES

. . . We'll be glad to supply engineering assistance, and actual samples of these 200-Series steels for testing under your processes and conditions.

ADDRESS DEPT. MD-80

In the top photograph, the fabrications you see are a mixing bowl, a tea-kettle base, a lock case and a patented shoe fastener: all made of A-L Type 201 or 202 chrome-manganese low-nickel stainless. The finish is good, the steel handled the same in the presses as Types 301 or 302, and similar drawing, buffing and polishing procedures were followed.

As in the lower illustration, the chrome-manganese low-nickel grades are being used also for fabrications as large as truck trailers and railroad coaches. Again, forming qualities and weldability present no problems, and results are entirely satisfactory.

Sum it all up and this is the answer: you *won't* encounter any particular differences in fabricating the 200-series of stainless steels . . . you *will* find some advantage in price, and a very important factor of much greater availability in times of nickel shortage. ● Why not take advantage of our pioneering experience with the low-nickel grades—let us help you use them. ***Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.***

WSW 6060

For Stainless Steel in ALL Forms—call

Allegheny Ludlum

AL STAINLESS STEEL ®

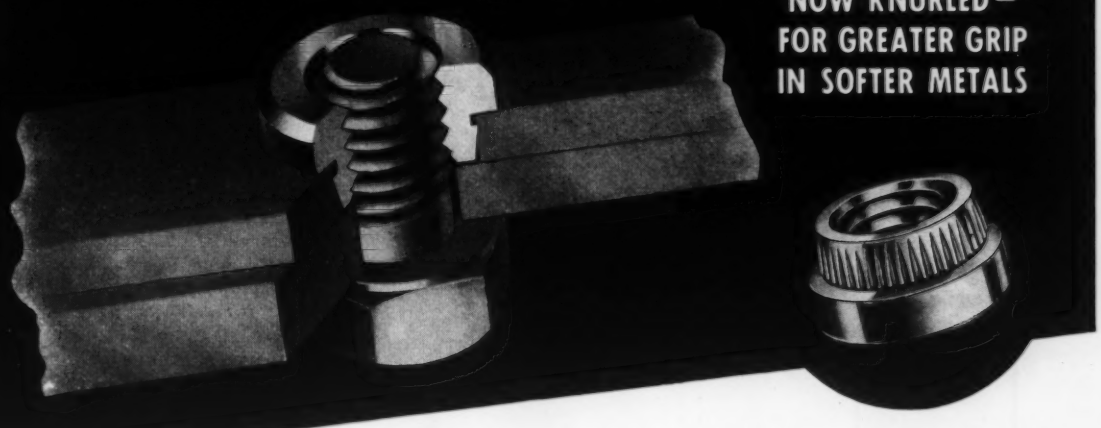
Warehouse stocks carried by all Ryerson Steel plants

Circle 641 on page 19

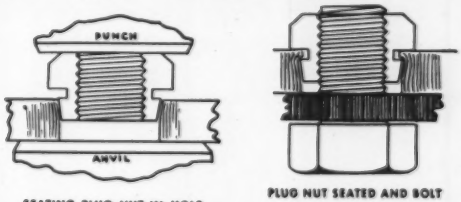
Planning New Products?
Redesigning Old?

PLUG NUTS

NOW KNURLED—
FOR GREATER GRIP
IN SOFTER METALS



Here's How Lamson Plug Nuts Work



SEATING PLUG NUT IN HOLE

PLUG NUT SEATED AND BOLT TIGHTENED DOWN

The Lamson Plug Nut has long been a favorite for assembling a wide variety of products. It is fast, efficient, inexpensive and can be hopper-fed on "automated" assembly lines.

Now Lamson & Sessions has improved this highly efficient, easy to use nut by knurling the portion that is inserted in the drilled or punched hole. This assures a tight, non-slip grip even in softer metals like copper, brass, magnesium and aluminum.

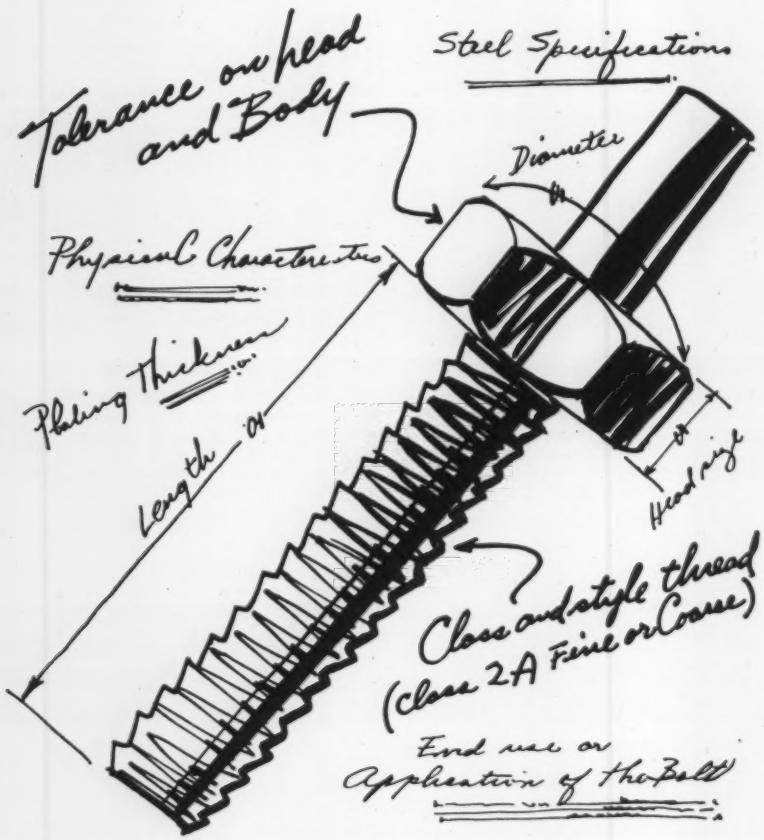
If you are still using or are planning to use awkward or expensive fastening methods, write for the whole story on Lamson Plug Nuts. You will discover a modern new way to save time and money on your assembly line!

The nut is pressed into a punched or drilled hole of a predetermined diameter in ferrous or non-ferrous material. As the nut is inserted the material is compressed radially so that when the groove passes the top surface, the elasticity of the material will cause it to flow slightly into the groove, thus holding the nut in place.

Plug Nuts are made for use in any thickness of material down to .030" and in any tap size from No. 4 to ¾".

The LAMSON & SESSIONS Co.

1971 West 85th Street • Cleveland 2, Ohio
PLANTS AT CLEVELAND AND KENT, OHIO • BIRMINGHAM • CHICAGO



FROM A SKETCH

as rough as this...

Special fasteners that improved product design and function at reduced cost have often been engineered from ideas sketched on a pad. At Buffalo Bolt, experienced fastener designers welcome the opportunity of engineering your roughs into practical designs to do your intended job. Equally important, our production men know just how to produce them to meet your schedules.

Of course, we are always ready to quote on finished designs for specials, too.

EITHER WAY, you can be sure of fast, experienced cooperation when you call in Buffalo Bolt.

BUFFALO BOLT COMPANY
Division of Buffalo-Eclipse Corporation
NORTH TONAWANDA, N. Y.

● *3 convenient service centers*

WESTERN OFFICE	EASTERN OFFICE	CENTRAL OFFICE
Chicago	New York City	North Tonawanda
HArrison 7-2179	REctor 2-1888	JAckson 2400 (Buffalo)

Many **GOOD** *products can be made* **BETTER** *...with* **SPECIAL FASTENERS**

Circle 643 on page 19

The Engineer's Library

(*Concluded from Page 233*)

tute Research Foundation; 253 pages, 8¼ by 10¾ in., paperbound; available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.; $5.00 per copy.

This book is a report of the energy absorption characteristics of cushioning materials impacted under a heavy-weight, high-impact, shock machine and analyzed by an analog computer system. For a wide range of materials, dynamic performance curves are given on two kinds of graphs: energy versus maximum stress, and maximum stress versus maximum strain.

♦

Investigation of the Effects of Corrosion on the Service Life of Ball Bearings, PB 111829. *By James C. Hanson, Rock Island Arsenal Laboratory; 44 pages, 8 by 10½ in., paperbound; prepared by the Ordnance Corps, U. S. Army; available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.; $1.25 per copy.*

Seven groups of single-row, radial ball bearings, size 307, each with a different degree of laboratory-produced stain or corrosion, were life tested and compared with one group of 30 new, class A-1 bearings. The average service life is reported for lightly stained bearings, and for bearings exposed to salt spray for 60 minutes and 120 minutes.

♦

NACA Technical Series. Each publication is 8 by 10½ inches, paperbound, side-stapled; copies available from National Advisory Committee for Aeronautics, 1924 F St., N.W., Washington 25, D. C.

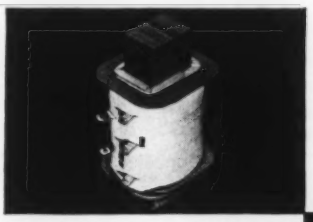
The following Technical Memorandums are available:

1393. **Flow of Gas Through Turbine Lattices**—136 pages.

The following Technical Notes are available:

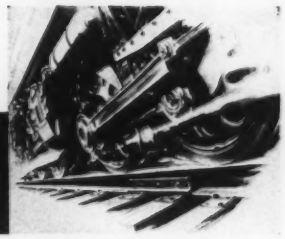
3657. **Friction Studies of Graphite and Mixtures of Graphite with several Metallic Oxides and Salts at Temperatures to 1000 F**—16 pages.

3681. **Investigation of Plastic Behavior of Binary Aluminum Alloys by Internal-Friction Methods**—44 pages.

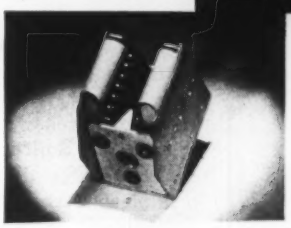


DIELECTRIC STRENGTH. National Vulcanized Fibre gives electrical parts high dielectric strength—plus toughness and excellent forming properties. Has ideal application as insulation.

NATIONAL VULCANIZED FIBRE



DURABLE—TOUGH—RUGGED. National Vulcanized Fibre rail joint insulation withstands years of continuous exposure and heavy pounding of today's high-speed railroading. Will not corrode or deteriorate.

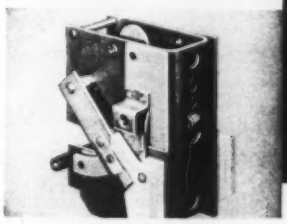


ARC RESISTANCE. In circuit breakers, National Vulcanized Fibre safely curbs electrical arcing without carbonizing or tracking. Easy to bend, punch and form. Light in weight. Heat-and-shock resistant.

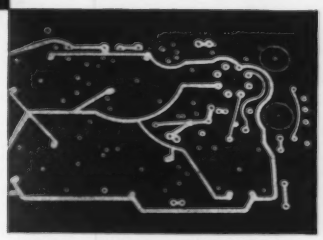
FOR MEN WITH IMAGINATION . . .

two materials of unlimited application

MACHINABILITY— MECHANICAL STRENGTH. New paper-base PHENOLITE not only has excellent arc resistance, but superior machining qualities as well. Great compressive and tensile strength.



CHEMICAL RESISTANCE. Chemical-resisting grades of PHENOLITE are unaffected by most corrosive fluids and atmospheres. Retain high strength, resiliency and dimensional stability.



COMPACT DESIGN—ECONOMY—HIGH TEMPERATURE RESISTANCE. Printed circuits made of Copper Clad PHENOLITE permit compact design, simplify production, reduce assembly time.

Here are six ideas to spur your imagination. They only suggest the many things that are being done better at lower cost with versatile Vulcanized Fibre and PHENOLITE® Laminated Plastic.

The full list of current and new uses for National Laminates would more than fill this page and many more! These are coming up almost every day. For the property range of National Laminates is a designer's dream. *Over 80* basic materials grades available in sheets, rods, tubes, rolls, coils or fabricated parts.

FREE GUIDE TO LAMINATED PLASTICS

National's new materials comparator chart directs you quickly and easily to the right material for your application.

Compares specific properties of 35 basic materials grades—over 600 property values!

For your FREE copy, write direct to Dept. G-8.

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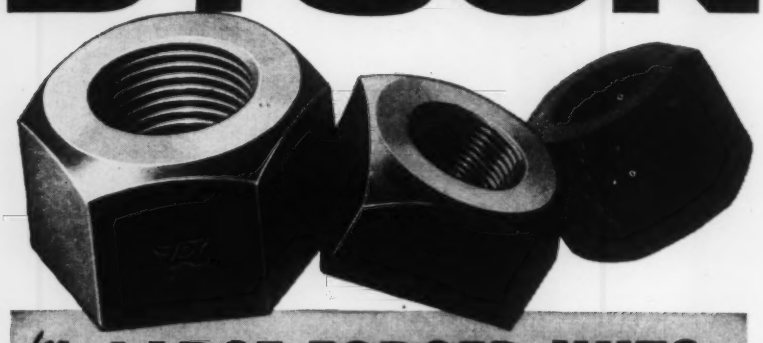
In Canada: **National Fibre Company of Canada, Ltd.** • Toronto 3, Ont.

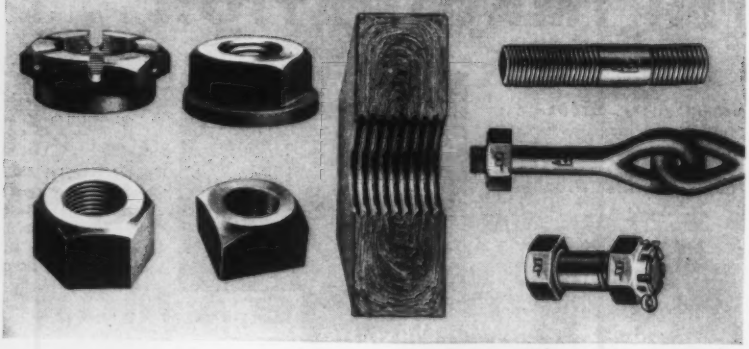
VULCANIZED FIBRE • PHENOLITE LAMINATED PLASTIC • NATIONAL NYLON • PEERLESS INSULATION • KENNETT MATERIALS HANDLING RECEPTACLES • VUL-COT WASTEBASKETS • LESTERSHIRE TEXTILE BOBBINS • VULCOT PRODUCTS FOR THE HOME

Circle 644 on page 19

DYSON

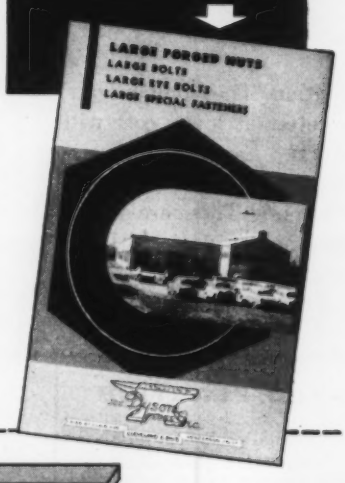


for your **LARGE FORGED NUTS BOLTS • BLANKS**



• This 36-page large fastener catalog contains complete dimensions, specifications and prices on Dyson large forged nuts. Dyson large nuts, bolts and blanks are forged in a modern plant devoted exclusively to large fasteners. Prompt service on special requirements. Adequate Steel Stocks, machining and heat treating facilities.

Write for Your Copy...



JOS. Dyson & SONS Inc.

5125 ST CLAIR AVE. CLEVELAND 3, OHIO HENDERSON 1-6157

THERE'S NO SUBSTITUTE FOR QUALITY

Circle 645 on page 19

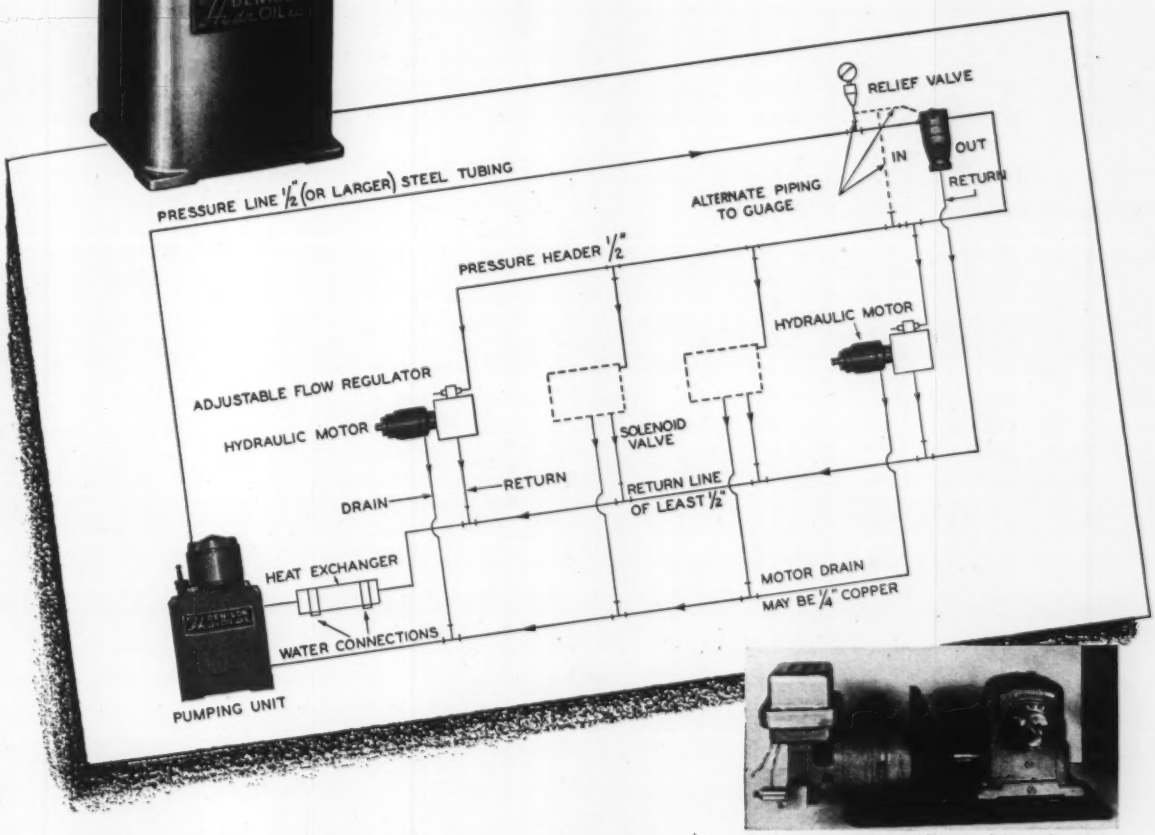
New Machines

Domestic

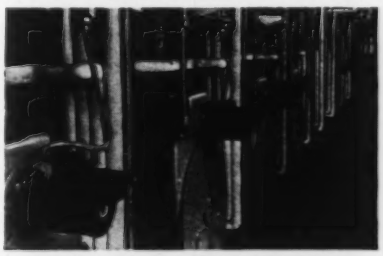
Kitchen Appliances: Redesigned line includes built-in wall ovens, countertop fold-back cooking units, drop-in surface cooking units for installation in the counter and large capacity undercounter dishwashers. Built-in wall ovens have a removable divider which, when in place, permits two different temperature operations simultaneously. Ovens are equipped with automatic controls. Redesigned fold-back surface cooking units, finished in stainless steel, are equipped with a safety switch which turns off heat automatically when units are folded away. Heat settings are illuminated on vertical switch control panels. Automatic undercounter dishwashers provide large capacity, flexibility and ease of loading. Entire washing cycle is pushbutton-controlled. A revolving cylinder located between the racks rotates 500 times per minute, directing jets of water to all parts of the dishwasher. A 600-w heating unit keeps water hot and speeds up drying action. Appliances are available in pink, grey, yellow, green and white. *General Motors Corp., Frigidaire Div., Dayton, O.*

Motion Picture Projector: Kodascope Analyst II permits detailed study of athletic and instructional films at speeds ranging from 5 to 24 frames per second. Projection speeds are obtained by means of a variable rheostat control and minimum-maximum speed governor. Design incorporates separate universal motors for film-running mechanism and constant-blower cooling system; remote control switch for instantaneous reversals controlled at a distance from the machine; heat-resistant lens coatings; silent projection of sound films as well as silent films; permanent prelubrication; and built-in daylight projection viewer for desk-top film analysis under normal room lighting. The projector

Four-color printing register controlled within .002 inches with Denison Hydraulic Equipment



Each compensator idler is driven from the sprocket of this gear reducer which is driven by the Denison axial-piston fluid motor. A solenoid valve controls motor operation in response to signals from the compensator amplifier. (Below) Selector switches mounted on the end of each print cylinder shaft generate electrical signals to indicate the angular position of the cylinder.



Did you ever notice how one color overlaps another on the Sunday comic pages?

Getting colors to register properly on high-speed presses is one of the most difficult tasks in modern printing. But the HURLETRON register control system, developed by Electric Eye Equipment Company and powered by Denison hydraulic equipment overcomes the problem . . . actually controls register within .002 of an inch.

Denison hydraulic pumps and motors respond instantly to electronically-developed signals, a major factor in the pinpoint accuracy of Electric Eye's control system. Only one hundredth of a second is required for an adjustment to be made.

The key to the entire system is a Denison fixed displacement, high pressure, high volume vane pump. Denison's fluid axial-piston motor and Multi-Range Flow Control contribute to the highly dependable operation of this printing aid.

Hundreds of similar experiences by equipment manufacturers prove how Denison hydraulic pumps and motors solve difficult control problems with unusual simplicity. Write for full details.

THE
DENISON ENGINEERING COMPANY
1240 Dublin Road • Columbus 16, Ohio
A Subsidiary of American Brake Shoe Co.

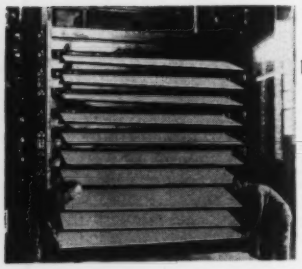
DENISON Hydr OIL ics

Circle 646 on page 19

VERSATILITY

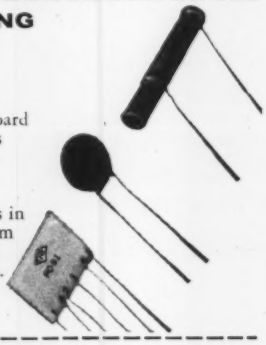
in Resins...

● **BONDING...OR COATING**



Wood particles are bonded into durable board and molded products with Durez resins.

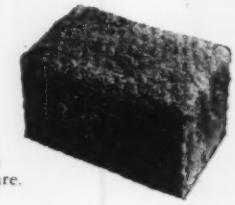
In electronics, resins in dip compounds form tough, dust-proof, heat-resistant coatings.



● **HOT...OR COLD**

Braking generates heat, but the resin bond in linings prevents "fading", adds wear.

In refrigerator insulation, a protective bond of resin safeguards batts from moisture.



● **RESILIENT...OR HARD**

Resins are used widely in rubber stocks and adhesives to add reinforcement and wearing qualities.

...and for exceptionally high shock resistance, molding materials are bonded with Durez resin.

...do these suggest benefits for your business?

These examples suggest only a few of the many ways in which business is profiting from the characteristics of Durez phenolic resins. Their qualities of insulation, toughness, and resistance to extremes of temperature and humidity, and to attack by many acids and mild alkalies hold wide promise for investigation into profitable new uses. If your product or processes call for impregnants, bonds, coatings, or reinforcing agents, we may be able to help you. Our experience as leaders in the development and production of phenolics is at your service.

DUREZ®

Phenolic Plastics that fit the job

DUREZ PLASTICS DIVISION

HOOKER ELECTROCHEMICAL COMPANY

508 Walck Road, North Tonawanda, N. Y.

HOOKER CHEMICALS PLASTICS

Circle 647 on page 19

New Machines

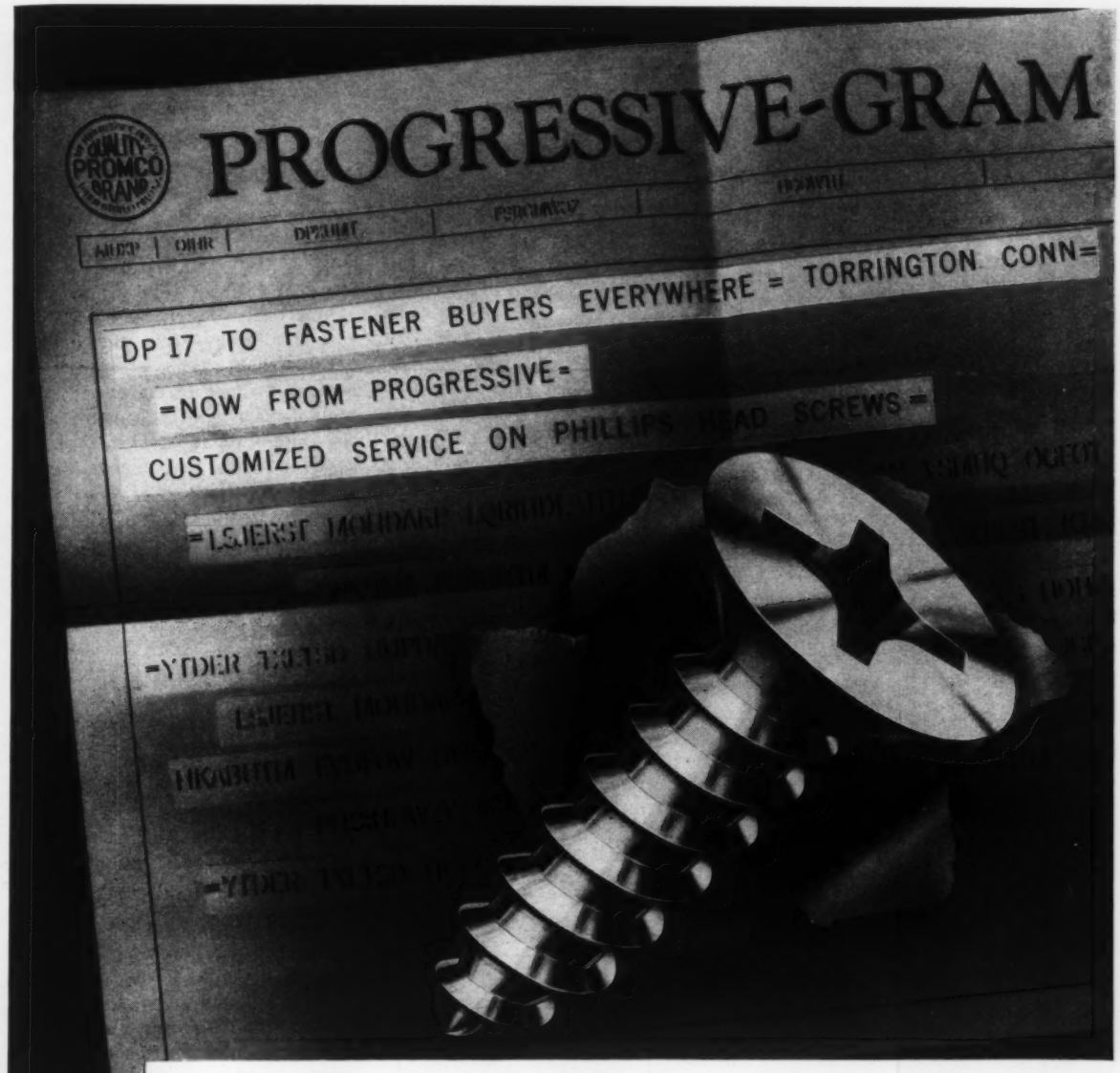
is equipped with a 2-in. projection Ektanon f/1.6 lens, 760-w lamp and 400-ft reel. Two motors permit operation on 105-125 v dc or 25-60 cycles ac. *Eastman Kodak Co., Rochester, N. Y.*

Sickle Bar Mower: Model H Champion sickle bar mower makes possible fast and easy cutting of high grass, weeds and brush. Lightweight aluminum engine delivers 2.75 hp, permitting the use of a 44-in. sickle bar. Cutter bar follows ground contours, and cutting height is 1½ in. Design features include screw-adjustable knife clips that maintain accurate settings for long cutting efficiency, two independent clutches for safe starting and instant control, two forward speeds, adjustable handlebars, and 16-in. rubber wheels that grip solidly on all types of ground surfaces. The sickle bar can be replaced quickly by a power sprayer, rotary tiller-cultivator or snow thrower. *Jari Products Inc., Minneapolis.*

Materials Handling

Industrial Tractor: Model LTW-E four-wheel industrial tractor, steered and driven like an automobile, is designed for use in general tractor applications. It has four-wheel suspension, low seat height to reduce overhead clearance problems, and simple controls located at the rear end of the truck. A clear view of the coupler is provided. Hydraulic brakes are standard equipment. Overall length is 76½ in. Tractor is available with a selection of motors giving drawbar pulls up to 4000 lb. *Automatic Transportation Co., Chicago.*

Ram Trucks: Electric-powered, heavy-duty ram trucks have capacities from 20,000 to 80,000 lb. Design incorporates narrow overall width, caster-type trailing axle, steel mill-type electrical controls, redesigned lifting mechanism, and hydraulic power steering and wheel brakes. Use of center sill frame construction makes possible attaching all subassemblies directly to the frame so that each can be removed independently. Propeller shaft construction of the power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=NOW FROM PROGRESSIVE=
CUSTOMIZED SERVICE ON PHILLIPS HEAD SCREWS=

Now you can get from PROGRESSIVE Phillips Head Screws with an extra customized touch — Phillips Head Screws which are custom-made to your order. This means: (1) specifically made for you — not bin stock parts; (2) fast, custom-handling of every order; *plus* (3) the double economy of low initial cost *and* the savings in your assembly operations possible only with high precision, torsion-tested fasteners.

STANDARDS AND SPECIALS CUSTOMIZED FOR YOUR NEEDS

THE PROGRESSIVE MFG. CO.
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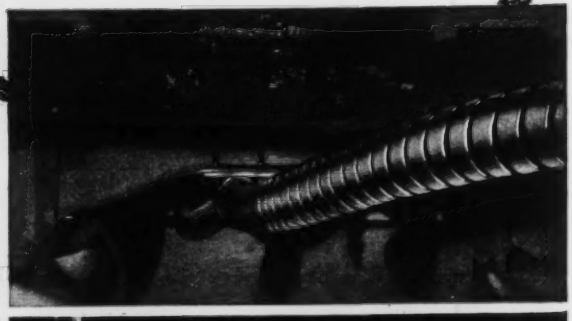
Circle 648 on page 19

STOW flexible shafting
ON THE JOB



pumping GAS on a tractor-trailer

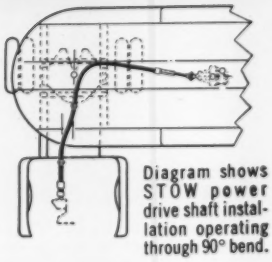


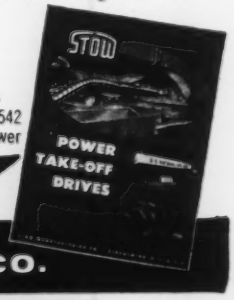
Diagram shows STOW power drive shaft installation operating through 90° bend.

STOW Flexible Shafts have effectively solved power take-off problems on both trucks and tractor-trailers. Large shafts, such as the 1¼" pictured above which transmits up to 10 H.P., have proven their ability on power take-off applications more efficiently and with more trouble-free service... **to operate pumps** for petroleum, milk and other liquids; **to operate conveyors** for grain, coal; **to operate compressors** on refrigeration trucks.

Why not put Stow to work on your power drive problems? Stow Engineers are always at your service.

For complete engineering data and illustrations on STOW Flexible Shafting—Write today for FREE Bulletin 525.

Write today for Bulletin 542 and complete data on Power Take-Off drives.



STOW MANUFACTURING CO.
11 SHEAR ST., BINGHAMTON, N.Y.

Circle 649 on page 19

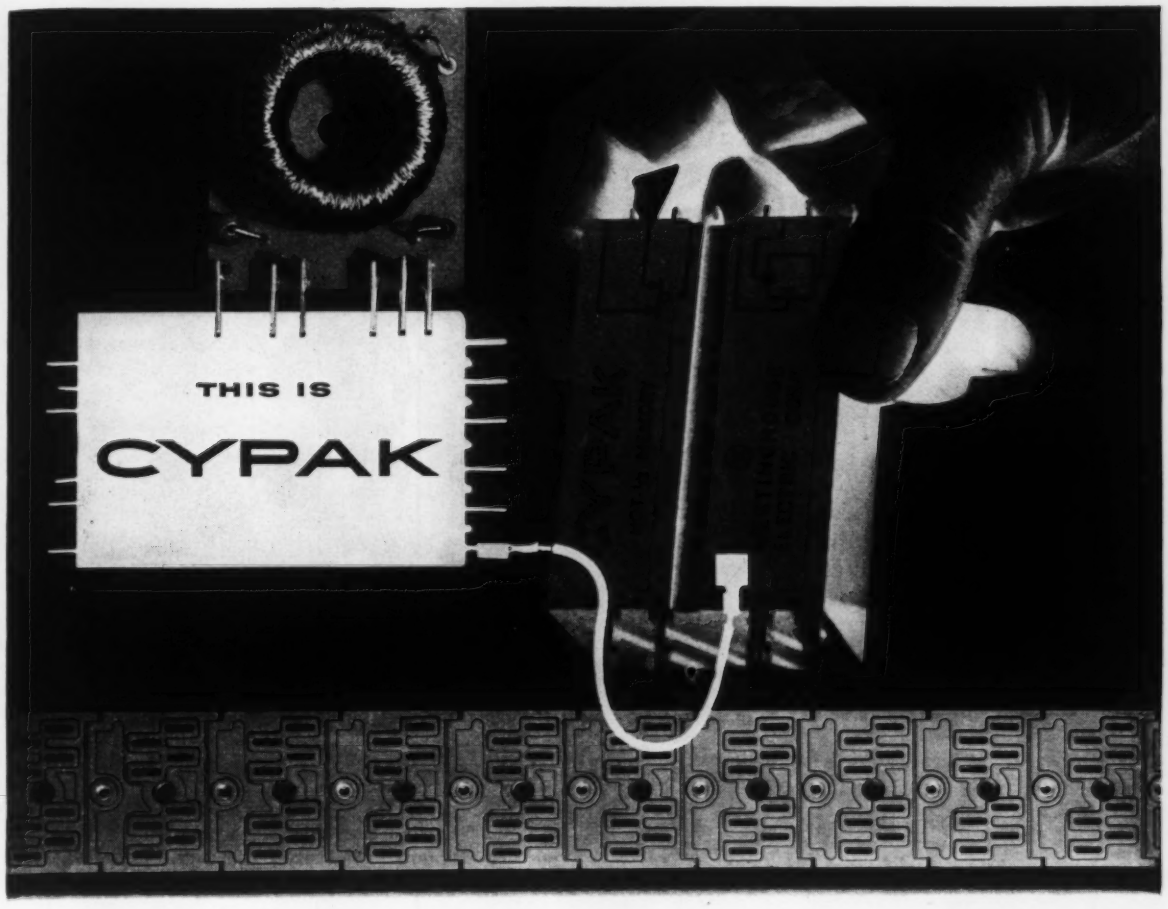
New Machines

plants permits removal of the motor without disturbing reduction unit. Easy access is provided for all pressure lubrication fittings and contactor controls. Rollers on the elevator are mounted on eccentrics which permit adjustment for wear. Trucks are powered by two electric motors. Each motor drives a pair of front wheels providing positive drive for all four wheels. Power transmission to both pairs of wheels is provided by means of separate drive reduction units consisting of a primary worm reduction with integral differential combined with a spur gear second reduction. *Elwell-Parker Electric Co., Cleveland.*

Lift Truck: K51-AT electric sit-down lift truck with 4000-lb capacity is only 67 in. long, permitting operation in aisles as narrow as 10 ft 6 in. With no load the truck can travel from 6 to 6½ mph; under load, speeds from 5½ to 6 mph can be achieved. Loads are lifted at speeds of 25 to 30 fpm, and empty forks can be raised at 45 to 50 fpm. Redesigned caster wheel steer provides reduction in steering effort. Stability is provided through the use of four widely spaced carriage rollers bearing against the channels, in addition to four channel thrust rollers to resist off-center loading side thrust. The truck tilts 11½ deg backward, and channels can be tilted forward 5 deg. Drive and pump motors are series wound with armature shafts mounted on ball bearings. Motors have silicone insulation for protection against high temperatures. The model has four speeds forward and four reverse, controlled by Cam-O-Tactor time delay control. *Yale & Towne Mfg. Co., Yale Materials Handling Div., Philadelphia.*

Metalworking

Rotary Gear Shaver: Red Ring model GCJ-48 in. rotary gear shaver expands the field of crown shaving to include external gears up to 48-in. pitch diameter and 62 in. between centers. Spur and helical gears up to 12 in. wide and 52 in. OD in the 2 to 16 diametral pitch range can be crown shaved, and



for industrial control 15 times more reliable

With CYPAK* control you can introduce a whole new concept of reliability for industrial systems. Unlike the mechanical relay, CYPAK has *no* moving parts. While twenty million open-close cycles is usually the maximum life of a mechanical relay, CYPAK systems can handle that many cycles in days, without a trace of fatigue. Down time due to wear, corrosion, or jamming no longer throws a block to expanding control system responsibility.

One reason for CYPAK dependability is Westinghouse Hipernik* V magnetic steel. In toroidal coils, this high-grade steel produces sharp current amplification to parallel the mechanical relay step function. These important magnetic characteristics are completely protected by sealing each CYPAK component panel in a solid plastic block.

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WATCH WESTINGHOUSE

WHERE THE FUTURE IS ALREADY IN PRODUCTION!

The hydrocarbon reformer furnace tubes shown here were furnished to The Girdler Company, of Louisville, Kentucky, leading designers of gas processing plants and equipment.

Picture of Teamwork...

ACIPCO

Centrifugally Spun

STEEL TUBES

Outstanding teamwork between the staff at Acipco and its customers has solved many difficult design and fabrication problems. Shown here, studying the results of this teamwork, are a customer's project engineer, an Acipco engineer and an Acipco inspector. They are part of the supplier-buyer team that produced a new hydrocarbon reformer furnace tube, designed and fabricated to operate at 1700 degrees Fahrenheit and over 100 psi. Over 400 of these tubes, completely fabricated and tested at Acipco, will soon be serving the petroleum refining industry.

Among the specifications for these tubes are:

Tube Analysis: Austenitic stainless steel, centrifugally spun.
100% radiography of all welds.
Hydrostatic testing at 1100 psi.
Air testing at 100 psi.

Call on Acipco's combination of teamwork, manufacturing know-how, and integrated facilities for spinning, heat treating, machining, fabricating and testing, to produce the *exact* steel tubes you require. You'll get quality plus a saving.

SIZE RANGE: Lengths up to 16'—longer lengths by welding tubes together. OD's from 2.25″ to 50″; wall thicknesses from .25″ to 4″

ANALYSES: All alloy grades in steel and cast iron, including heat and corrosion resistant stainless steels; plain carbon grades and special non-standard analyses.

FURNISHED: As cast, rough machined, or finish machined, including honing.

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shaving without crowning can be done on spur and helical gears up to 36 in. wide and 142 in. between centers in the same tooth size range. Cutter head is mounted on a saddle at the rear of the machine. The work drives the cutter which is meshed with the work gear in crossed-axes relationship during the shaving process. Either manual or automatic means can be used to feed the cutter into the work in selected increments from 0.001 to 0.003-in. at the end of each stroke of the cutter. Direction of rotation of the work is reversed at each end of each stroke to assure uniform shaving of both sides of the teeth. Axial travel of the saddle is controlled by a clutched transmission which provides both feed and traverse speeds. Separate motor drives are provided for headstock rotation, cutter reciprocation and coolant pump. *National Broach & Machine Co., Detroit.*

Drilling Machines: Horizontal type Micro drilling machines make possible consecutive hole finishing operations, including drilling, chamfering and reaming, with multiple tooling, without removing the workpiece from the machine or individual tools from tool quills. The units also have collets, chucks or special work-holding fixtures on the headstock. Spindles are supported on preloaded precision ball bearings; quill drive is through an adjustable ball bearing friction device that allows free axial movement of the quills. Holes up to ⅛-in. can be drilled without undue slippage. *Jedco Inc., Micro-Drill Guide Div., Cincinnati.*

Lathes: Imperial Type M series precision-geared toolroom lathes have instantaneous direct-reading preselector for spindle speed control; speed can be changed while the machine is operating. Direct-reading selector is also provided for the quick-change gearbox. All major units are totally enclosed and pressure lubricated. Tailstock spindle unit has built-in ball bearing revolving tapered seat to center. The unit has 18 spindle speeds

(*Continued to Page* 248)

SPRING CLIP NUTS
Pre-Positioned Metal Fasteners
either welded on, clinched on, or clipped on
SOLID WELD NUT
CLINCH NUTS
NUT WASHERS
Mount Clemens Metal Fasteners, pre-positioned in your assembly, meet your requirements for attaching method, panel alignment and torque at substantially reduced assembly costs.
Nut and Washer assemblies provide self-locking, panel hole sealing and electrical grounding in any desired combination.
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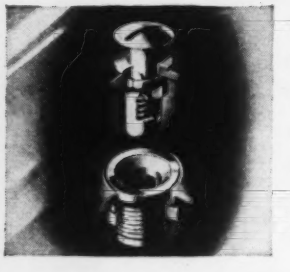
Economy • Quick installation • Flexibility of design •

Whatever your application, Simmons Fasteners will fill your needs. Leading manufacturers are using Simmons Fasteners with perfect results in a wide range of products.

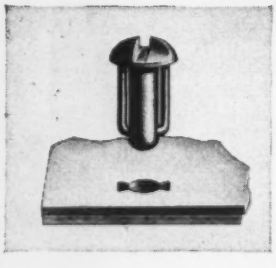
QUICK-LOCK



Millions in use on weather-tight lighting units, battery chargers, truck heaters, engine cowlings, access panels and doors, radio equipment covers, gas tank covers, map and data cases, transmitter cases, voltage regulators...

Easy to install, QUICK-LOCK is ideal for assembling removable panels and access doors. A 90° turn locks it in place. Stud is self-ejecting when unlocked; visual inspection shows whether fastener is locked. Spring loading takes initial load; solid supports carry increased load. Available in various sizes with choice of stud and receptacle types.

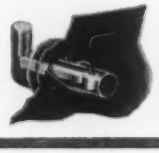
SPRING-LOCK



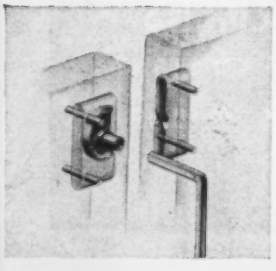
The perfect, proved fastener in such applications as removable covers and panels on electric and electronic equipment, railroad locomotives and diesels, all sheet-metal automobile parts, shipboard equipment, home appliances...

SPRING-LOCK, one-piece fastener for blind holes, has load-carrying steel spring wire. Spring steel arms lock it securely, prevent loosening under vibration. SPRING-LOCK is self-adjusting for various material thickness, locks with a twist of the wrist.

Plastic SPRING-LOCK Shelf Supports, with the strong "heart of steel," are available in your specified color...used by all major appliance manufacturers to cut costs, speed production, simplify servicing in refrigerators, ranges. Custom molded to your design requirements.



ROTO-LOCK



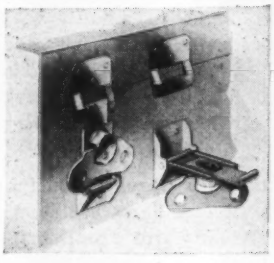
Ideal for portable Arctic region shelters, partitions, cabinets, built-ins of all kinds, desks, tables and other demountable furniture, knock-down shipping boxes, demountable refrigeration units, caskets, point-of-sale display assemblies...

ROTO-LOCK makes butt or right-angle joints easily. Tapered cam design permits secure locking even in misaligned or semi-open position. Carries heavy tension and shear loads; can be used for air and water-tight seals. Solidly built without springs or delicate mechanical parts; unaffected by sub-zero temperatures.

you every advantage...

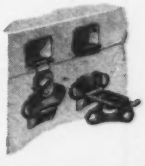
Strength · Positive locking · Smooth fastening action

LINK-LOCK



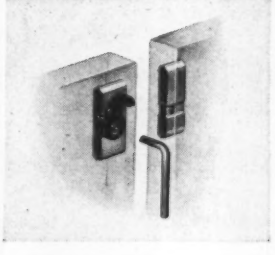
Available in 3 sizes—heavy, medium, light duty. The perfect latching device where positive or heavy locking pressures are necessary, and where lock will have to withstand rough service. Proved in portable aircraft hangar construction, containers, military transit cases, instrument cases...

The springless latching device for use wherever pre-loaded closure is required. *(Also spring-loaded. See below.)* Impact and drop-resistant, LINK-LOCK provides heavy fastening pressure and high load-carrying capacity. Excellent for water and pressure-tight sealing. Withstands 70-below temperatures.



New! Spring-Loaded LINK-LOCK...medium and heavy duty...ideal for less expensive containers where costs won't permit precision production. Spring provides take-up to compensate for set in gasketing, irregularities of sealing surfaces.

DUAL-LOCK



An absolutely vibration-proof, impact-proof high-load fastener that will not accidentally unlock or loosen...ideally suited for demountable structures, guided missile assemblies, shipping containers, aircraft cowlings and sheet metal guards, and all butt-joint fastening...

Double-acting take-up in DUAL-LOCK insures heavy closing pressure with minimum pressure on operating tool. Trigger action of DUAL-LOCK assures full open and closed positions. Can be recessed in panels or surface mounted. Withstands 7000-lb. tension, and can be readily modified for light load applications.

Send today for your copy of the 40-page Simmons Fastener catalog, which gives specifications, applications, installation instructions. Samples of all Simmons Fasteners are available.

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FASTENER CORPORATION
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Circle 653 on page 19

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Circle 654 on page 19

New Machines

(*Continued from Page 245*)

up to 1310 rpm. Gears and shafts are high-carbon chrome-nickel steel, hardened and ground. Large spindle is mounted on three precision anti-friction bearings with standard taper key-drive nose. Enclosed multiple-disk friction clutch provides forward, stop and reverse of the spindle either from the headstock or apron. *Aaron Machinery Co. Inc., New York.*

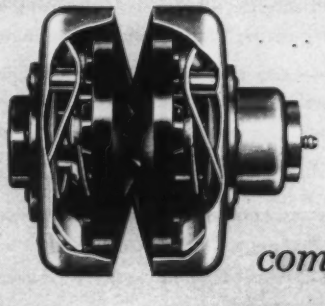
Broaching Machine: Model 60-90 ElectroGear horizontal broaching machine is fully automatic, including automatic transferring of parts into and out of the work station. Ram speed is infinitely variable from 30 to 150 sfm. The machine uses either carbide or high-speed steel broaches. Power for the ram is supplied by a direct current motor served by a motor generator set. Driving motor is coupled to a gearbox containing a cone-drive double enveloping worm gear set driving a precision helical pinion. Pinion drives a rack mounted directly to the ram. All hydraulic and electrical controls are interlocked and meet JIC standards. Jog control panel is provided for machine setup and tryout runs. *Colonial Broach & Machine Co., Detroit.*

Power Plant Equipment

Diesel Electric Set: D342 electric set utilizes a compact, self-regulated generator, built specifically for the diesel engine incorporated in the set. Voltage droop and terminal voltage can be adjusted on the generator to meet the needs of special installations. After adjustment the controls are locked. The set is easily paralleled with other generators. *Caterpillar Tractor Co., Peoria, Ill.*

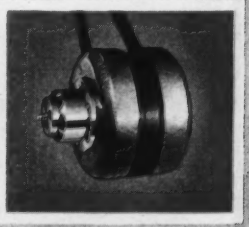
Rotary Oil Burners: Oil burners with integral air registers are available in sizes from 9 to 125 gph. They will fire with No. 6 or lighter oil, and are designed for either natural or induced draft with approximately 0.10 to 0.15-in. wc required for full rating. Integral air register assures maximum combustion efficiency over

DESIGN-WISE...



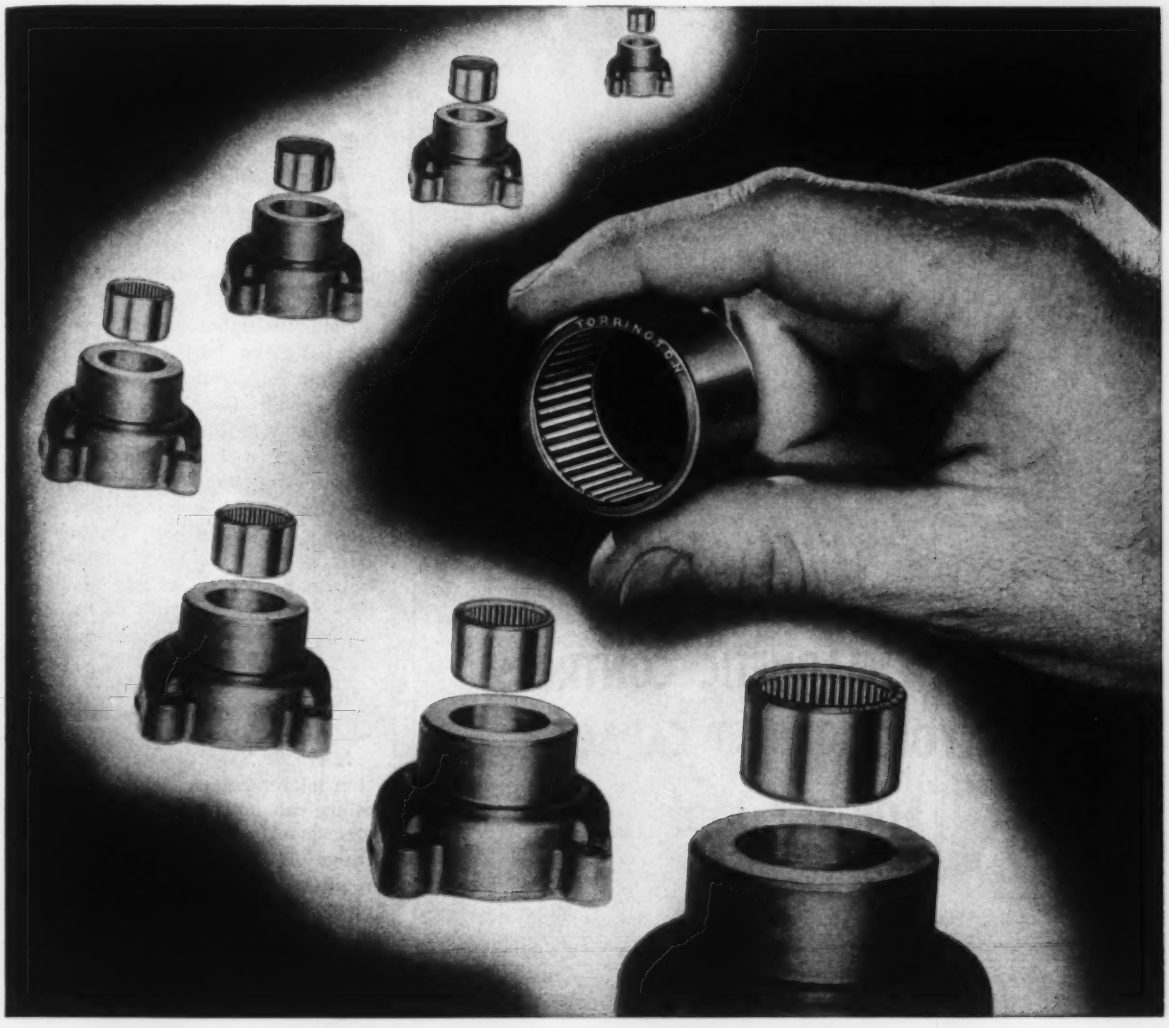
this simple pulley solves complicated problems

Compactness of *HI-LO* automatic variable speed pulleys simplifies basic machine design in a vast range of applications. The exclusive design of cam followers on cams provides simple, positive pitch diameter setting control. Springs in HI-LO pulleys are not driving members as in most spring-loaded pulleys, but serve primarily to keep the pulley faces in contact with the belt. Belt wear is reduced to a minimum because the belt is never under any more tension than is required by the load. Free technical manuals with diagrams, descriptions of applications and other power transmission data are available from:



Equipment Engineering Company
2855 Columbus Ave., Minneapolis, Minnesota

Circle 655 on page 19



The **TORRINGTON NEEDLE BEARING** *is a natural for volume installation*

You can install Torrington Needle Bearings with greater rapidity than any other type of anti-friction bearing. Today, automatic arbor presses are widely used throughout industry for large volume installation—possible because of the Needle Bearing's unique unit construction.

Since no collars, shoulders or retaining rings are needed, Needle Bearings require only a simple housing. Consequently, an operator can turn out a tremendous number of assemblies every hour. A surface-hardened shaft serves as the inner race. Ease and speed of installation cut costs on your assembly line—a large production benefit.

For more than twenty years our Engineering Department has helped designers and manufacturers throughout industry to adapt the superior advantages of the Needle Bearing to their products. Let us help you make the Needle Bearing "standard" equipment in yours.

See our new Needle Bearing Catalog in the 1956 Sweet's Product Design File —or write direct for a catalog.

TORRINGTON NEEDLE BEARINGS
Give you these benefits

- low coefficient of starting and running friction
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- low unit cost
- long service life
- compactness and light weight
- runs directly on hardened shafts
- permits use of larger and stiffer shafts

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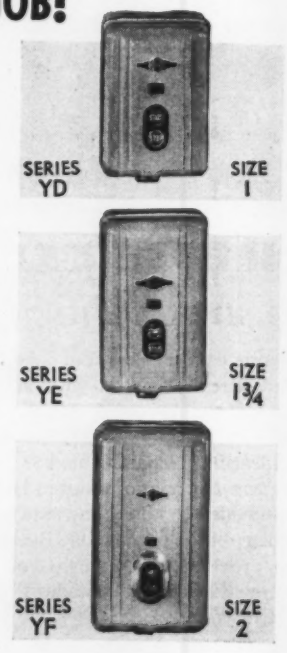
Circle 656 on page 19

FURNAS MAGNETIC CONTROLS GIVE YOU CORRECT CAPACITY FOR THE JOB!

The many in-between sizes in the Furnas Electric starter line let you select the motor control that is best suited for your particular requirements—with no wasted capacity and expense. By matching the starter to the job you can *save up to 25%*. For proof, we invite your comparison of the Furnas Electric line of starters consisting of 10 sizes with the 5 sizes normally offered.

And you can *save up to 40%* in space by securing the correct size starter for the job. Furnas Electric produces more stock sizes of starters in the 1-100 hp range than other control manufacturers.

WRITE FOR BULLETIN 5530— 1045 McKEE STREET, BATAVIA, ILLINOIS



A6

FURNAS ELECTRIC COMPANY
BATAVIA ILLINOIS

Circle 657 on page 19

New Machines

a wide firing range. Combustion air is introduced through the firing port, facilitating thorough mixing of oil and air and cutting excess air to a minimum. Modulating type automatic actuator provides correct amount of fuel and air to maintain desired water temperature or steam pressure. Primary combustion air is supplied by the burner fan; secondary air is introduced through the air register. Electronic safety controls automatically shut off the burner if a hazardous condition arises. Programming control sets up the proper sequence of operations in stopping and starting the burner. Sensitive limit control operates the burner to hold temperature or boiler pressure at the necessary level. *Iron Fireman Mfg. Co., Cleveland.*

Testing and Inspection

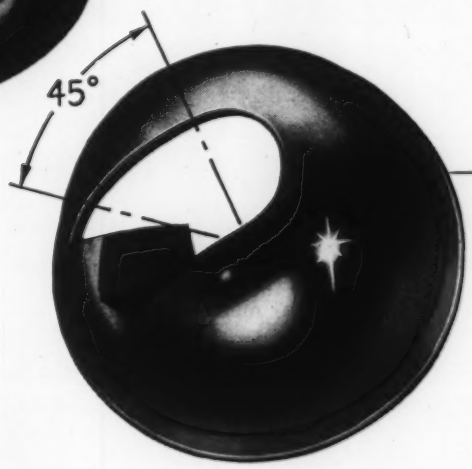
Microhardness Tester: Combination microhardness tester and metallurgical microscope of nondestructive type has a load-weight range of 25 to 1000 grams and requires one minute for a complete test cycle. Vertical capacity is 2⅜ in., and the maximum spread of standard vise jaws is 1 11/16 in. Surface finishes of 40 rms or less can be inspected, and indentations of 0.0004-in. or smaller can be measured to within 0.00008-in. The spot to be indented can be located to within 0.0002-in. Interchangeable vise accessories permit the instrument to be used for testing small precision ground or lapped parts, small diameter wires, thin materials or material coatings, thin sheet stock, cutting tool edges and ball bearings. A green light in the head of the instrument shows when the indenter is in contact with the work, and a red light indicates when load cycle is complete. Workpiece is raised to the indenter by handwheel. When the unit is used as a metallurgical microscope, the interchangeable objective lenses provide magnifications of 200 and 400X. A camera can be attached to the eyepiece for making photomicrographs. *Sheffield Corp., Dayton, O.*

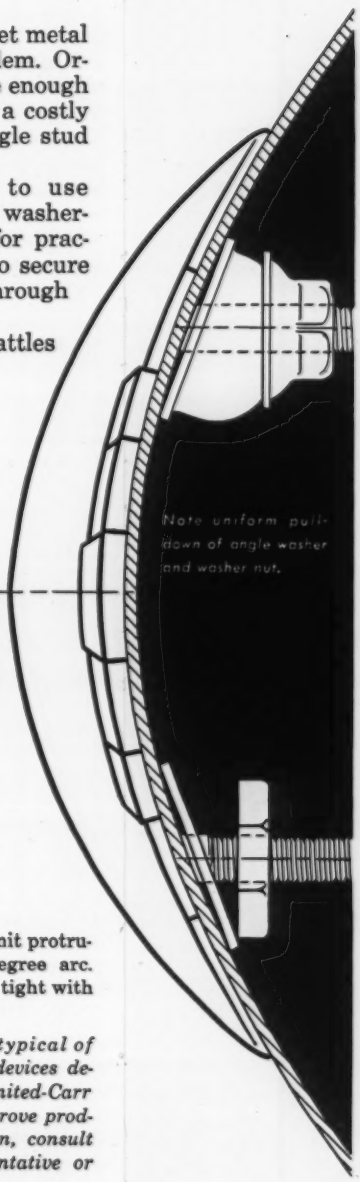
DOT's new angle washer holds cast trim against curves

Fastening die-cast trim to curved sheet metal surfaces can be a troublesome problem. Ordinary nuts jam before they get close enough to hold tight. One solution has been a costly mould construction permitting off-angle stud casting.

The modern cost saving way is to use United-Carr's new angle washer and washer-nut combination. This compensates for practically any curve or can be used to secure studs that protrude at an angle through a flat surface.

Tight fastening is assured and rattles never get a chance to start.





Light, strong metal shell is slotted to permit protrusion of stud at any angle within 45 degree arc. Washer nut matches shape of shell, locks tight with normal wrench torque.

The angle washer and washer nut are typical of thousands of special-purpose fastening devices designed and manufactured in volume *by United-Carr to help speed assembly, cut costs and improve product performance. For further information, consult your nearest United-Carr field representative or write us for his name and address.*

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This new Dodge No. 8 Torque Arm Reducer with a capacity of 60 h.p. at 100 r.p.m. utilizes a Formsprag Series 50 Backstop Clutch. Bob Haas (left), Formsprag District Manager discusses its operation with Alec Bodle (right), Chief Engineer, and David Firth, Vice President, Engineering of Dodge Manufacturing Corporation.

"Sure, we use Formsprag Clutches to insure maximum precision, long life . . . here's why . . ."

"Dodge Torque-Arm Speed Reducers are built for efficiency up to 97%—as demonstrated in thousands of installations.

"Precision preformance like this means that every component part must perform with extreme accuracy—and be able to take it!

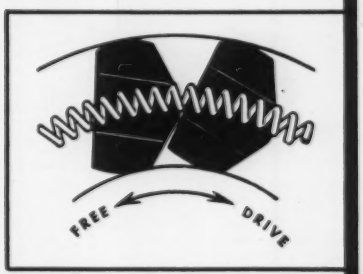
"That's why Formsprag Clutches are used for built-in backstops in our speed reducers. Not only do they offer maximum torque in a minimum area, but they've proven their 'long-life' capabilities in thousands of diverse applications."

Dodge is just one of the myriad of industrial manufacturers taking advantage of these Formsprag Clutch design features:

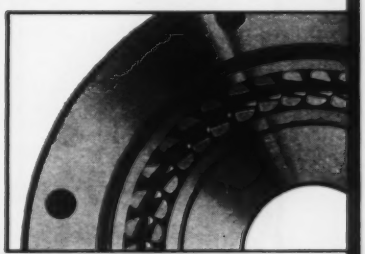
- HIGHER TORQUE CAPACITY
- LONGER LIFE
- INTERNAL SIMPLICITY
- NO MEASURABLE BACKLASH
- EXCEPTIONALLY LOW MAINTENANCE

Why not put Formsprag's experienced engineers to work for the betterment of your product? Write today for comprehensive literature.

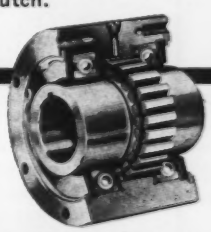
HOW FORMSPRAG'S SIMPLE PRECISION DESIGN WORKS FOR YOU:



Sprags used in Formsprag Clutches are highly developed, precision wedges of hardened alloy steel. Due to the sprag's design, an unusually high amount of torque is delivered from one concentric race to the other. When torque is applied, the sprags are instantaneously engaged. When torque is removed, the sprags release instantaneously.



Basic construction of the Formsprag Clutch is simple. A full complement of sprags is inserted between inner and outer concentric races. Contact with both race surfaces is maintained by energizing springs. Formsprag construction allows more sprags to be inserted in a smaller area than other clutch designs. Result: greater torque capacity in a smaller clutch.



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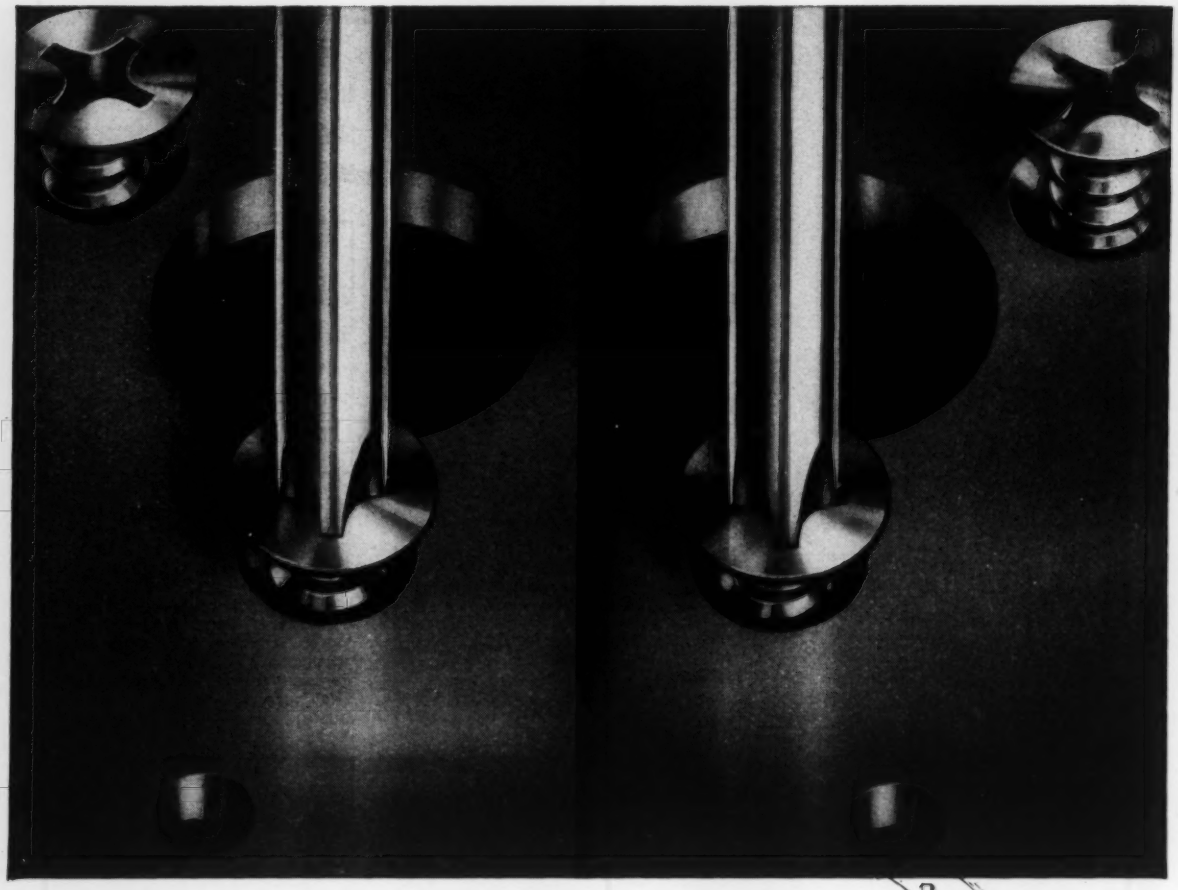
Circle 659 on page 19



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2. service **4. research**

Sometimes there are local price differentials for the moment. But no one gives you more of all four than American.

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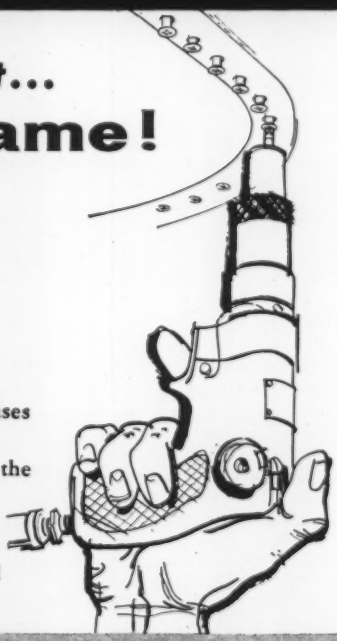
. . . *in quality*, where American's quality standards are highest in the industry to assure conformance of every product run.

. . . *in research* that has developed not only the original Phillips Head fastener but saved an aircraft manufacturer substantial sums by showing him how to change from a costly stainless steel fastener machined from bar stock to a sturdy cold-headed unit.



If this sounds unique in the industry, it is. For nowhere will you find more of the four basic features you want than from American Screw Company — price, service, quality, research.

Make your own comparisons . . . send us your inquiry for price and delivery or your specifications for special fasteners. Write:

American!

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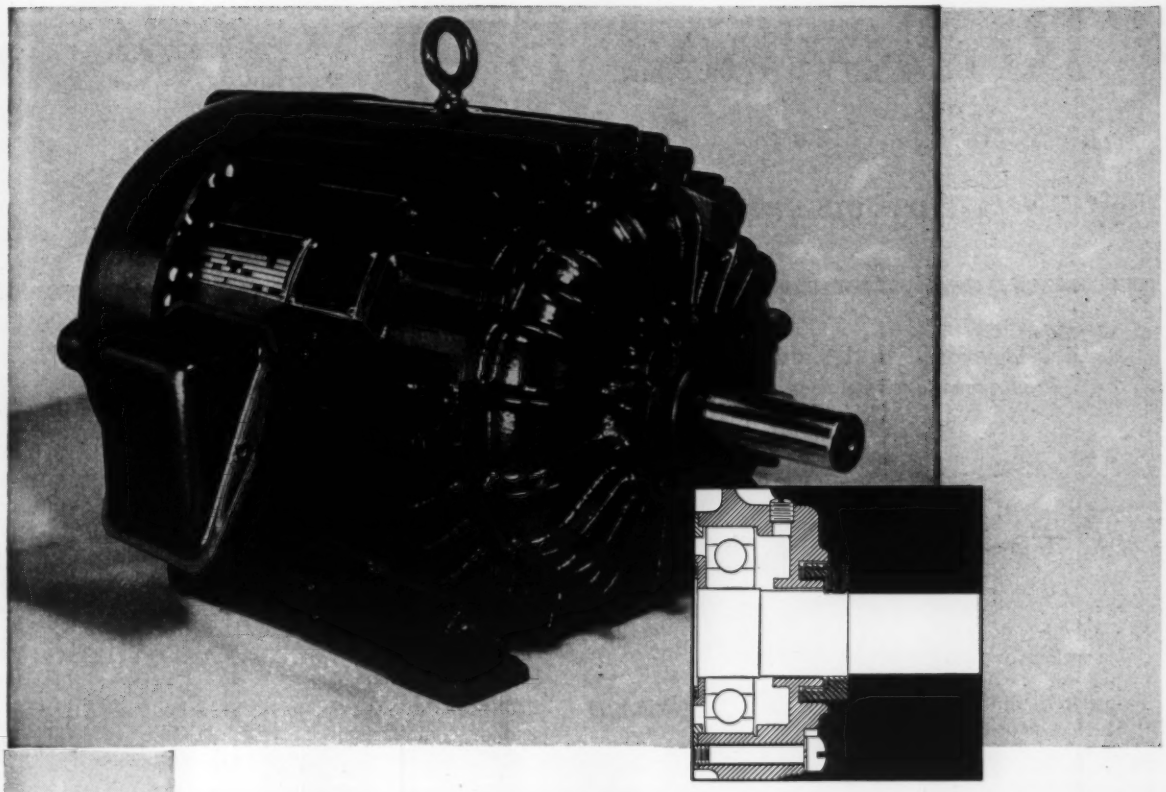

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- *Full round pipe size flow*
- *¼ turn opening and closing*
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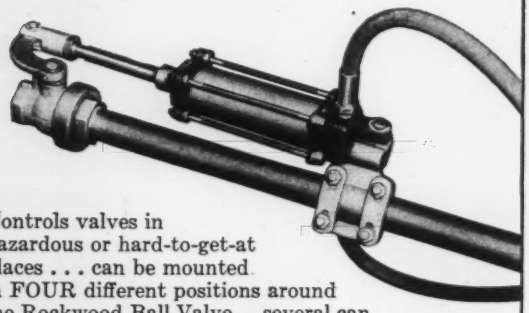
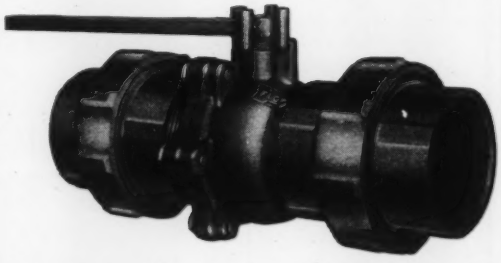


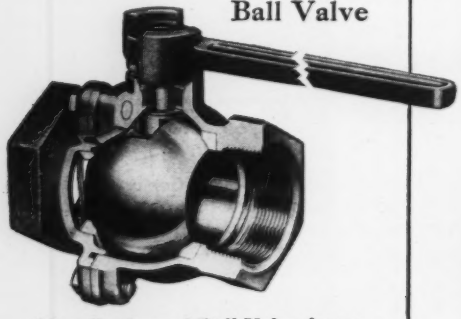
Controls valves in hazardous or hard-to-get-at places . . . can be mounted in FOUR different positions around the Rockwood Ball Valve...several can be controlled from one control board...available in a complete package unit from your distributor.

Male Thread Bronze Ball Valve



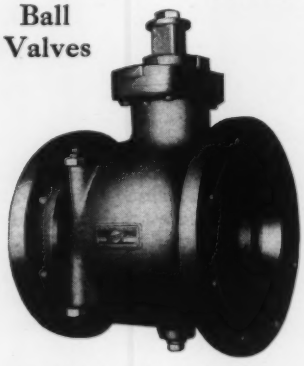
Full flow . . . with thread end, flanged end, union end or combination of same available with this valve. Longer life . . . greater strength. Size 2½" only.

Steam Ball Valve

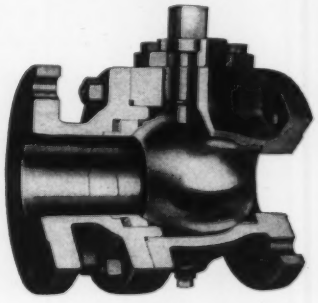


New Rockwood Ball Valve for use with steam handles up to 125 pounds of steam per square inch and 350 degrees F, with ease . . . opens and closes quickly. Pipe sizes ⅜" to 2".

6" and 8" Cast Steel Ball Valves



3" and 4" Cast Steel Ball Valves



Combines best features of plug cocks, gate and globe valves . . . made of medium carbon cast steel that meets specifications for carbon steel pressure castings as embodied in ASTM. Also made in other materials.

ROCKWOOD BALL VALVES

Write for complete data to Rockwood Sprinkler Company, 1223 Harlow St., Worcester 5, Mass. Distributors in all principal industrial areas.

ROCKWOOD

Tested and listed by Underwriters' Laboratories, Inc.

Circle 662 on page 19

if suddenly your products begin to test more faithfully to design . . . If your production line is running more smoothly . . . If "identical" installations stop showing varied results . . . If rejects drop . . . or stop . . .

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Would You Spend 30 cents to Save a Dollar?

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HAS MANY USES OTHER THAN STRICTLY ROD END APPLICATIONS

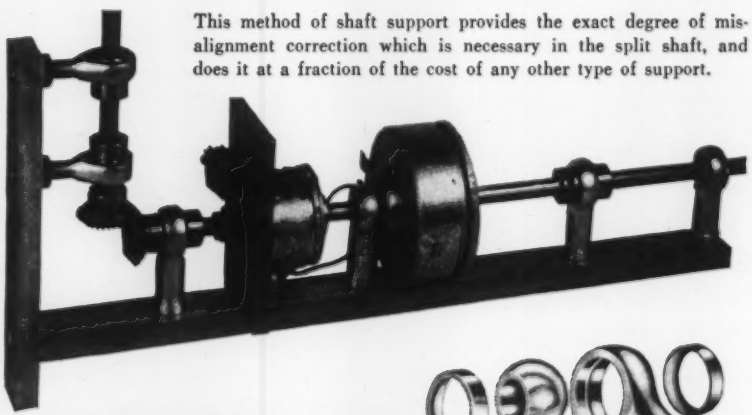
Depending upon size and quantity, some HEIM Unibal Spherical Bearing Rod Ends cost 30¢—even as low as 26¢ each. More and more manufacturers are discovering that a Heim Unibal can very often replace a special part, a weldment, assembled screw machine parts, or other specially machined component . . . which may have cost over a dollar to produce. Savings effected have run into substantial sums.

Take this clutch assembly

with its split shaft and bevel gears, as used in the Van Buskirk marking machine, as an example of how these inexpensive Heim Unibals act as adjustable, self aligning supports for both the horizontal drive shaft and the vertical driven shaft.

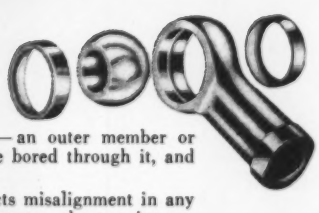
The drive shaft is supported by four female Heim rod ends, which are attached to the frame with hex-head bolts through drilled holes. The assembly is that simple.

The vertical shaft is held in place by two male Heim rod ends. These are screwed into drilled and tapped holes and locked in place with nuts and lock washers.



This method of shaft support provides the exact degree of misalignment correction which is necessary in the split shaft, and does it at a fraction of the cost of any other type of support.

THIS EXPLODED VIEW →



shows the components of the Heim Unibal—an outer member or body, a hardened and ground ball with a hole bored through it, and two bronze bearing inserts.

The universal motion of this single ball corrects misalignment in any direction. Lubrication is in the groove left between the two inserts. Grease fittings can be supplied for relubrication.

Unibal presents a larger bearing surface and can support greater axial and thrust loads.

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THE HEIM COMPANY
FAIRFIELD, CONNECTICUT

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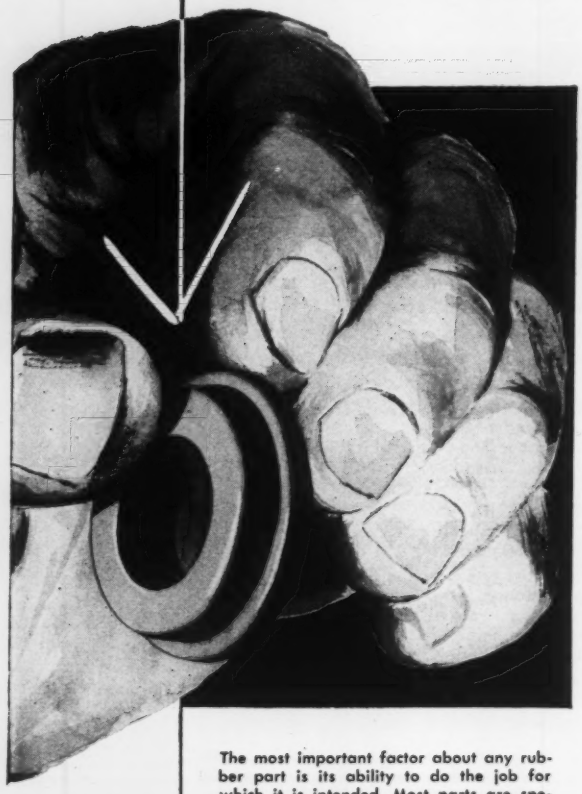

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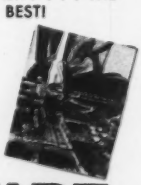

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STALWART
RUBBER COMPANY
180 Northfield Road • Bedford, Ohio

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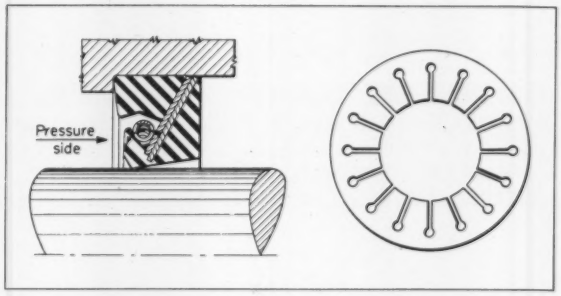
Circle 666 on page 19

NOTEWORTHY Patents

Shaft Seal

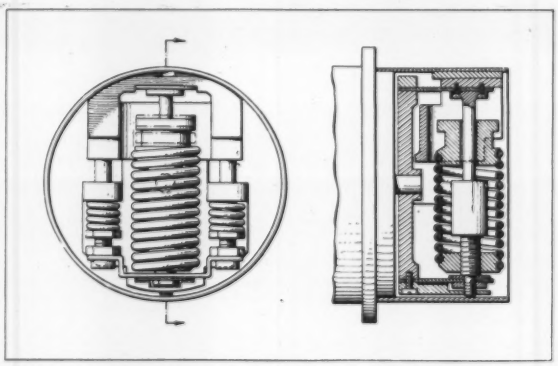
Reinforcing toothed spring washers, molded in a shaft seal, flatten and expand under fluid pressure, preventing seal misalignment with consequent losses in efficiency. Spring movement under pressure engages the flexible sealing lip firmly against the shaft



and simultaneously tightens the grip of the seal body on the housing wall. Shaped like truncated cones, springs can be either Belleville or finger types. *Patent 2,736,584 assigned to General Motors Corp. by Ellwood F. Riesing.*

Brake-Type Governor

Speed of small electric motors is held to 0.1 per cent of design point by a brake-type centrifugal governor. When motor runs at on-speed condition, a spring-retained brake shoe frictionally engages the stationary governor drum, dissipating a small



amount of rotational energy. A second spring-mounted mass complements the action of the brake shoes so as to dissipate more energy when design speed is exceeded. Reduction in motor speed below the set-point value reduces frictional engagement of brake shoe, permitting motor to accelerate to de-

Why the trend to heat-treated cap screws in the heavy equipment industry?

Chicago Screw engineers worked with leading manufacturers to develop the high-strength, heat-treated screws that take more punishment and greatly reduce fastener costs

Strength, and the ability to withstand severe punishment, are prime requirements for fasteners used in heavy equipment. As a leading fastener source for most of the top manufacturers of heavy equipment, CHICAGO SCREW conducts a thorough research and development program aimed at steadily improving fastener performance.

A major result of this program is the development of the CHICAGO *carbon-restored* heat-treated cap screw, now replacing bright-finish fasteners for most heavy equipment applications. Design engineers have found the far greater tensile strength of the heat-treated fastener (see chart) gives a better fastening with fewer—or smaller—screws. This means less weight . . . and a considerable reduction in fastener costs.

In addition to greater strength, CHICAGO heat-treated cap screws prove far superior in withstanding fatigue, wear, shock and vibration. This is because a major cause of fastener failure—a surface layer of soft, decarburized steel—is eliminated by our unique Carbon Restoration process. Vital surface carbon is restored in a scientifically controlled process during final heat-treating, producing a fastener that's uniformly hard from core to surface.

Our engineers will be glad to advise you on designing to best take advantage of heat-treated cap screws. For complete information on cost savings you can get in your products . . . and a detailed version of the condensed tensile strength chart at right . . . drop a line to our Standard Products Division.

HOW TENSILE STRENGTH COMPARES

Diameter (Coarse Thread)	Bright Cap Screws Tensile Strength (Pounds)	Heat-Treated Cap Screws SAE Grade 5 Tensile Strength (Pounds)
¼	2,150	3,810
5/16	3,550	6,270
3/8	5,250	9,280
7/16	7,200	12,720
½	9,650	17,000
9/16	12,400	21,800
⅝	15,400	27,070
¾	21,400	40,100
⅞	29,500	53,040
1	38,700	69,590

THE CHICAGO SCREW COMPANY

DIVISION OF STANDARD SCREW COMPANY • ESTABLISHED 1872

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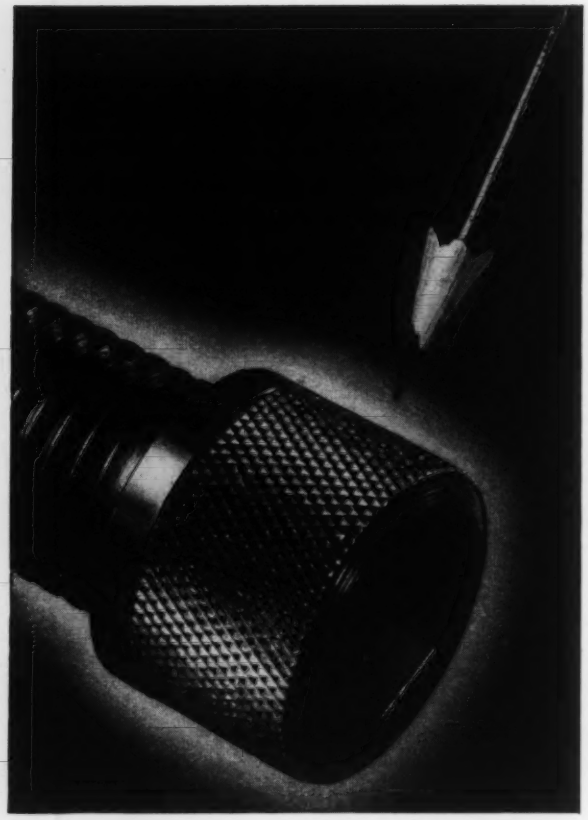
Circle 667 on page 19



For Quality Socket Cap Screws Look for the Bristol Diamond Knurl

The Bristol Diamond Knurl is the sign of a quality socket cap screw. It high-lights the overall care we take in producing these screws.

Everything about them has to be just right – or they don't pass our quality-control inspectors. As a result, every Bristol cap screw spins easily into place, fits perfectly and wrenches up tightly – so tightly that shock and vibration will never loosen them.

Ask your industrial distributor for the Bristol Diamond Knurled Cap Screws. He's got them in sizes from No. 0 and up in alloy and stainless steel. Most sizes are carried in stock for immediate delivery.

A.5.2

Precision Socket Screw Manufacturers Since 1913

*Made in sizes as small as No. 0 in Alloy Steel and Stainless Steel. Cap Screws up to 1½"

BRISTOL'S

BRISTOL'S SOCKET SCREWS

THE BRISTOL COMPANY, Socket Screw Division, Waterbury 20, Conn.

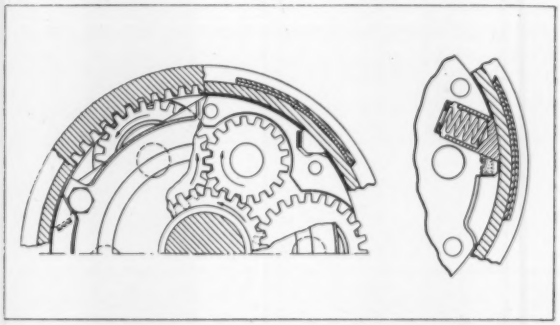
Circle 668 on page 19

Noteworthy Patents

sign speed. *Patent* 2,742,983 *assigned to Sperry Rand Corp. by Frederic L. Baxter Jr.*

Antirattling Planetary Gearing

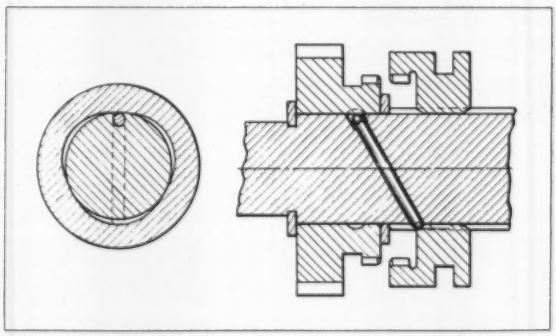
Vibratory motion or rattling between ring and planet gears is damped out by circumferentially spaced brake-shoe plugs in an antirattling planetary gear. Friction shoes, which are spring-mounted in slanting holes around the planet-carrier periphery, permit free relative motion in one direction between



the carrier and the ring-gear housing. Wedge-shaped facings of the shoes engage the inside face of the housing when rotation is reversed, damping out oscillations that may be initiated by power pulsations or normal gear backlash. *Patent* 2,735,310 *assigned to Studebaker-Packard Corp. by Forest R. McFarland.*

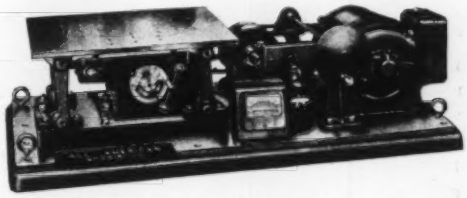
Jaw Clutch

A centrifugally positioned blocking pin, which passes diagonally through the driving shaft, prevents engagement of jaw teeth in a clutch designed to operate only at rotational speeds above a predetermined value. Pin blocks axial movement of the clutch coupling carrying the internal jaw teeth until



operating speed is attained. Complete engagement, forced by a spring-loaded shift yoke (not shown), is accomplished when the pin is centrifugally moved toward the driven clutch member, allowing axial movement of the splined clutch-half along the shaft. *Patent* 2,722,300 *assigned to Clark Equipment Co. by Robert Lapsley.*

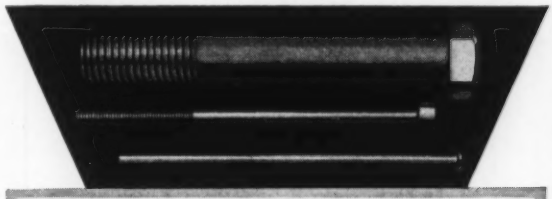
Range Selector Is Highlight Of All American Model 150 HLA-D Vibration Fatique Test Machine



This machine subjects parts or assemblies, up to 150 lbs. in weight, to a comprehensive vibration fatigue test. It has a 50% overload safety factor. Vibration in simple harmonic motion is produced horizontally. Displacement (double amplitude) is adjustable from 0" to 125". Automatic Range Selector controls acceleration and deceleration. From 10 cycles per second frequency may be increased uniformly to 60 c.p.s. and then decreased to 10 c.p.s. Any desired range within the total may be selected. Selector can be switched off and frequency held at any c.p.s.

Recommended for testing aircraft, electronic, electrical, mechanical or optical parts or components. One of 7 models. Send for Catalog F, containing helpful data, nomograph chart and listing typical users. Write to

ALL AMERICAN TOOL & MFG. CO.
8023 LAWNDALE AVENUE, SKOKIE, ILLINOIS
Makers of All American Precision Die Filing Machines.
Circle 669 on page 19



NATIONAL LOCK
Special-Purpose Fasteners

Save

ENGINEERING AND DESIGN TIME

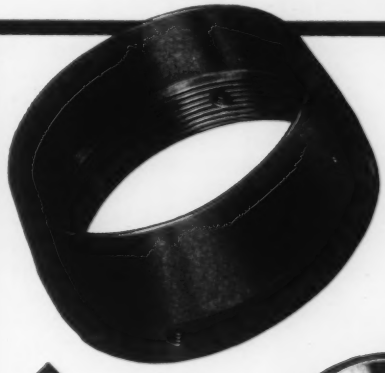
SPECIAL HEADS
SPECIAL SHANKS
SPECIAL THREADS

Call upon National Lock fastener specialists to participate in your early planning . . . before your designs are frozen. These experienced men will furnish complete details on National Lock screws and bolts of every type, size, finish and material.

NATIONAL LOCK COMPANY
Fastener Division · Rockford, Illinois

Circle 670 on page 19

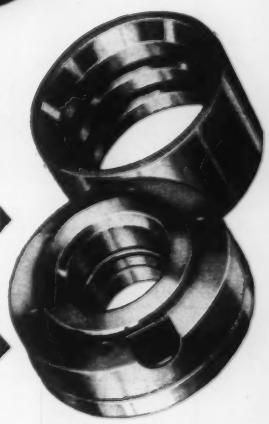
You Get BIG savings on ... runs of ... parts from WESTERN



This 4½" round alloy steel part has No. 12 pitch, class 3 fit internal threads, and requires 20 separate operations including pentrating and magnafluxing.

This 3¾" alloy steel part is hardened and ground. Tolerance of o.d. is just .0005".

This 4⅛" round part requires drilling, counterboring and recessing.



Ultra precision work is usually associated with small parts, but WESTERN is accustomed to .0005" tolerances on big parts, too—up to 4¾" round. As a matter of fact, we specialize in long runs of difficult, complicated parts and assemblies, and we deliver them the way you want them, when you want them.

Whether you're interested in big or small parts, plain or fancy, it pays to put WESTERN on your production team. We're equipped to do precision machining plus all finishing operations such as grinding, polishing, magnafluxing, heat-treating and pentrating.

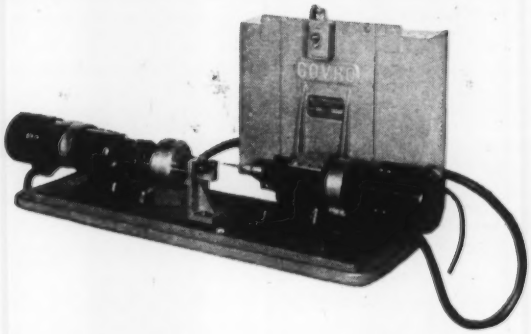
You save money, time and trouble by getting quotations on precision parts from WESTERN. *Write us today.*

The Western Automatic Machine Screw Company
division of Standard Screw Company
383 Woodland Ave., Elyria, Ohio

Precision Parts and Assemblies Since 1873

Circle 671 on page 19

New Machine Performs 3 Operations Automatically With One Loading



If you are faced with the problem of speeding up the drilling of small parts, it will be to your advantage to acquaint yourself with this new bench-type drilling machine which incorporates 2 Govro-Nelson Automatic Drilling Units, one with a 2-spindle head, originally designed for drilling and counterboring an aluminum collar.

The operator loads and clamps the part in a simple fixture, then depresses the start-cycle switch, whereupon the left-hand drilling unit automatically feeds forward and drills two holes. The withdrawal of the spindles causes the right-hand unit to feed in automatically to counterbore one of the two holes previously drilled.

With this simple set-up, the three operations are performed automatically at an output rate in excess of 300 pieces per hour.

By making slight changes in mounting and fixtures, the machine is readily adaptable to drilling a variety of parts. Send for complete information.

WRITE FOR Literature

Automatic DRILLING UNIT

GOVRO-NELSON CO.

Machinists of Precision Parts for 33 Years

1933 Antoinette **Detroit 8, Mich.**

Circle 672 on page 19

WALKER-TURNER

FLEXIBLE SHAFTING

Put it right up to our engineers to show you why W-T FLEXIBLE SHAFTING belongs in your product designs!

If you haven't considered W-T Flexible Shafting for your product designs that involve unaligned power drives and remote controls, you're missing some really BIG advantages. With W-T Flexible Shafting, you can eliminate complicated miter gears and many parts — and make your products more compact. You'll also cut down costs appreciably.

We're ready to prove that. Name your problems in power and control transmission, and let our W-T engineers go to work on them—without any obligation to you. Send the coupon today for FREE W-T Catalog and Data Sheets on Flexible Shafting.

WALKER-TURNER
INCORPORATED

Walker-Turner, Inc., — Plainfield, New Jersey:

☐ Please send me FREE W-T Flexible Shafting Catalog and Data Sheets. M2-8

☐ Tell me more about your engineering service.

NAME _____ TITLE _____

COMPANY _____

STREET _____

CITY _____ ZONE _____ STATE _____

Circle 673 on page 19

use a GRIPCO LOCK NUT

- To Hold Tighter
- To Last Longer
- To Cost Less

in these and hundreds of other applications where stress, wear or vibration is a factor. The Gripco Lock Nut, with its simple, one-piece design, has given industry a tighter, more positive holding action for quicker fastener application at less initial cost. No inserts, outside devices or complicated features – the Gripco Lock Nut holding or locking action is inherent in the nut itself – it costs less to use, gives an easier, faster locking and holds tighter for a longer time. Impervious to oil or water. For faster production, lower manufacturing and maintenance costs, look into the Gripco Lock Nut today.

GRIPCO PRODUCTS INCLUDE: Gripco Lock Nuts, New Gripco "Clinch" Nuts, Gripco Hi-Nuts, Gripco Pilot-Projection and Countersunk Weld Nuts with or without Gripco locking feature.

112

GRIP NUT COMPANY

103 Maple Ave., South Whitley, Ind.

Circle 674 on page 19

WECKESSER
CABLE CLIPS

of all nylon ....

for high heat or other severe conditions

of ethyl cellulose ...

for maximum economy in average conditions

Light weight, strong, chemically resistant. No short circuits, no grounds, no corrosion, no rust. Only one fastener needed. Sizes to 1¼ inches. Write for free samples and price sheet.

WECKESSER COMPANY

5715 Northwest Hwy., Chicago 30, Ill.

Circle 675 on page 19

Heading Specialists!

Our Headers, with a capacity up to 1/4" OD by 1 3/4" long, produce ferrous and non-ferrous parts by the cold-headed method combining strength with economy and speed. Supplemented by our Waterbury Farrel Slotters and Thread Rollers and our Brown & Sharpe Screw Machines — we are in a position to save you money!

• Write for our brochure and request for quotation.

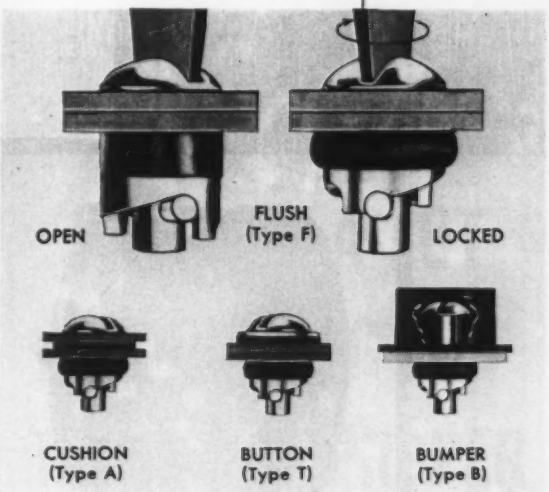
CONNECTICUT Mfg., Co.

125 Benedict St. • Waterbury 20, Conn.

Circle 676 on page 19

VIBREX
QUICK FASTENERS

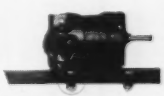
Now you can turn to BETTER FASTENERS



Revolutionary new General Vibrex® fasteners will lock, seal and cushion with one quick twist! This sturdy half turn rubber-and-metal fastener takes up misalignment, eliminates rattles and makes joints dust and waterproof. It is ideally suited for securing metal, plastic and glass panels and components.

Vibrex is supplied in a range of sizes and types. For further information write to The General Tire & Rubber Company, Industrial Products Division, Department 111, Wabash, Indiana.

Fan



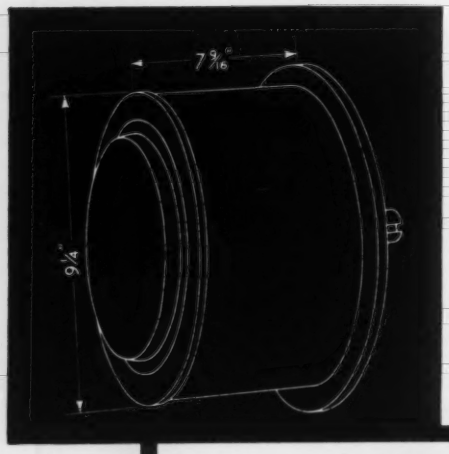
Motor

Chassis

Industrial Products Division
GENERAL
THE GENERAL TIRE & RUBBER CO.

THE GENERAL TIRE & RUBBER COMPANY
INDUSTRIAL PRODUCTS DIVISION
WABASH, INDIANA

Circle 677 on page 19



PANCAKE POWER

by Peerless®

● A machine tool manufacturer asked us to build him a motor with 1 HP; 1,750 RPM; single phase to fit a 7-11/16" space in the base of his lathes. This is the motor. It is totally enclosed to seal out the dust and chips encountered under shop conditions. The motor answers the requirements in every respect and gives him top product performance.

Peerless Electric develops hundreds of motors for OEM use. Let us tackle your motor problem. Peerless teamwork engineering—our engineers working with your engineers — will produce the one motor that powers your products best.

Emblem of BUSINESS CHARACTER Rice Leaders of the World Association

ELECTRIC MOTOR DIVISION

THE Peerless-Electric® COMPANY

FANS · BLOWERS · ELECTRIC MOTORS · ELECTRONIC EQUIPMENT

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Circle 678 on page 19

FASTEN, HINGE or PIN

with

DRIV-LOK PINS

FASTER ASSEMBLY... LOWER COSTS

POSITIVE ANCHORING ...won't come loose

DRIV-LOK Pins are responsible for great economies and product improvement in thousands of applications. For machinery, finished products, components and sub-assemblies, DRIV-LOK Pins offer definite advantages in time, labor and cost savings. We can help you better if you will write, giving us the nature of your problem. Catalog and Samples sent without obligation.

STANDARD TYPES . . . A COMPLETE LINE

WRITE FOR CATALOG

DRIV-LOK PIN COMPANY

715 Chauncy Street Sycamore, Illinois

Circle 679 on page 19

MAYLINE

the

MAYLINE MAY-O-MATIC

A table with effortless and instant height and tilt adjustments. Has solid Basswood steel end cleat top, sliding reference top, wide comfortable footrest.

Accessories are: Auxiliary Drawer Unit, 5-Drawer Plan File, Bookshelf. Write factory for more information.

Symbol of MAYLINE *Superiority*

Metal Plan File

MAYLINE CO., INC.

601 NORTH COMMERCE STREET

SHEBOYGAN, WISCONSIN

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Circle 680 on page 19

DRIV-LOK STUDS

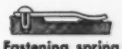
Save 60% Fastening Time!

- HOLD PERMANENTLY
- DISASSEMBLED EASILY WITHOUT DAMAGE TO COMPONENTS

Quick, simple insertion . . . Drill Hole and Drive Stud with a single blow.

TYPICAL APPLICATIONS

Attaching name plates or instruction panels



Fastening spring assemblies or control arms.

Widely used for fastening brackets.

Securing semi-permanent covers and closure plates.

3 HEAD STYLES

Round (standard) Flat (to order) Countersunk (to order)

Driv-Lok Studs save time and reduce costs in fastening name plates, covers, brackets, panels, etc, to heavier sections and for countless other applications involving light-to-heavy member fastening. Once installed, Driv-Lok Studs will not vibrate loose or fall out — yet they can be easily removed without damage to components. Made in 3 head styles. Write for illustrated catalog sheet, prices and samples.

DRIV-LOK PIN COMPANY

715 Chauncey St. • Sycamore, Ill.

Circle 681 on page 19

Circle 682 on page 19

IT TAKES A LOT OF DIGGING . . . TO MAKE A PROPER Spring!

Product engineers who have trouble solving their mainspring problems turn to Sandsteel whose own engineers have done considerable "digging" to design proper springs for their varied products. Sandsteel's unique *crosscurving* process — an ingenious concave-convex construction — solves problems connected with an even release of energy. It provides a reservoir of power . . . more energy per wind, a constant distribution of energy from wind to unwind.

If your product needs a flat-type mainspring, investigate Sandsteel's *crosscurved* springs. They'll add power and quality to your product.

Write for FREE LITERATURE ("Springs for Your Product") and CASE FILE, Dept. 33

30TH ANNIVERSARY

SANDVIK STEEL, INC.
Sandsteel Spring Division
Fair Lawn, N. J.

Circle 683 on page 19

Do you have the facts on Linear's new, exclusive ROTO-MOLD process? It brings *automation* to the packing industry—makes possible fast delivery of perfectly uniform "O" Rings in any quantity!

★ Linear ROTO-MOLD "O" Rings are made with laboratory precision in single cavity molds under individually controlled pressure. Molding dies are automatically brought into microscopic alignment.

★ Every ROTO-MOLD "O" Ring is perfectly circular in cross section, with no transverse or other seams. You get precise uniformity without trimming or grinding.

Linear ROTO-MOLD "O" Rings are available now, in a variety of sizes and compounds, to meet your exacting requirements. Write, phone or wire for complete details.

"PERFECTLY ENGINEERED PACKINGS"

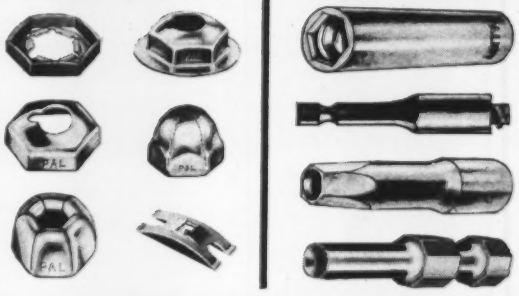
LINEAR

LINEAR, Inc., STATE ROAD & LEVICK ST., PHILADELPHIA 35, PA.

Circle 684 on page 19

High-speed Assembly Method!

PALNUT LOCK NUTS PLUS PALNUT SOCKET WRENCHES



RESULT: Vibration-proof assemblies, with big savings in assembly time and cost

Specially-designed PALNUT magnetized socket wrenches and shanks for all standard power and manual tools, permit picking up, starting and tightening in one high speed operation. No fumbling with hand starting. Fast, uniform tightening.

WRITE FOR CATALOG and folder showing PALNUT assembly methods

THE PALNUT CO.

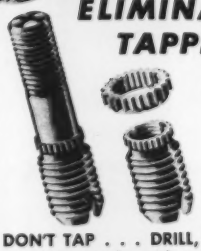
Subsidiary of United-Carr Fastener Corporation
75 Glen Road, Mountainside, N. J.
In Canada: P.L.Robertson Co., Ltd., Milton, Ont.

PALNUT TRADE MARK LOCK NUTS

Circle 685 on page 19

SAVE MONEY *and* GET SAFE, POSITIVE LOCKING!

ELIMINATE COSTLY TAPS, TAPPING and GAGING WITH ROSÁN SELF-TAPPING STUDS AND INSERTS



DON'T TAP . . . DRILL, DRIVE AND LOCK! It's that simple with money-saving, USAF approved ROSÁN Self-Tapping parts. Positively locked in with the Rosán Lock Ring, these fasteners can never loosen or back out. Made of the highest quality steels, they form their own perfect-fit threads. Easy to install, simple to remove. Many sizes available.

Install Rosán Self-Tapping or Standard parts to precise depth at high speed with the new Rosán Power Drive Tool. Fits any standard drill chuck. No special attachments, reversing spindles or friction clutches required.

SEND FOR MORE INFORMATION TODAY!

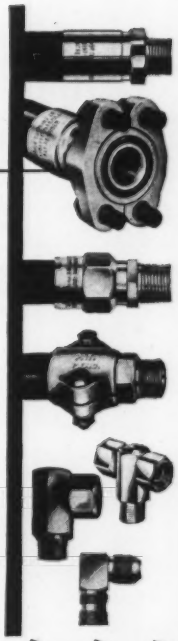
ROSÁN INC. NEWPORT BEACH, CALIF.

Offices in Principal Cities: U. S. and Canada

Circle 686 on page 19

Know that you have the Right Hose Assembly always — *Specify*

ANCHOR!



Whether it is for high, medium or low pressure, there's an Anchor Hose Assembly that's been designed for the particular type of job you have in mind! Anchor Couplings are engineered for long, dependable service without danger of leaks or blow-offs and with a substantial margin of safety over specified operating pressure ranges.

Andy Anchor says:
The catalogs listed below offer you a wealth of engineering data and the complete construction details of Anchor Hose Assemblies, Couplings and Fittings. Send for them!

Catalog No. 100 — Anchor Pressed-On Hose Assemblies

Catalog No. 201 — Anchor Adapter Unions, Pipe Fittings and the new SAE Boss Type Fittings — see SAE standards, Page 825, 1956 SAE Handbook.

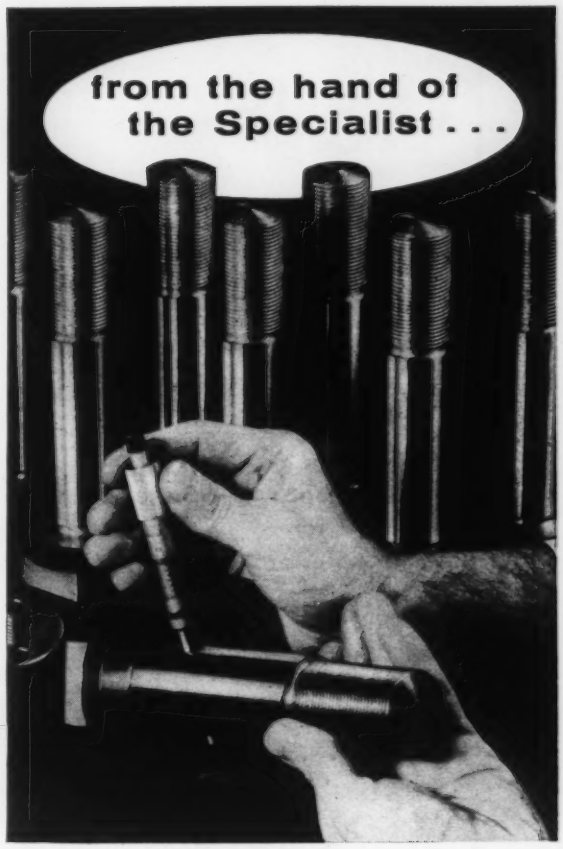
Catalog No. 301 — Anchor Clamp Type and Reusable Hose Couplings

Catalog No. 400 — Anchor Flanco 4 Bolt-Split-Flange Couplings — conforming to SAE standards, Page 823, 1956 SAE Handbook.

ANCHOR COUPLING CO. INC.

367 North Fourth Street, Libertyville, Illinois
Branch Offices: Dallas, Tex., Plymouth, Mich.

Circle 687 on page 19



To Your . . .
Specifications

ERIE Bolts • Studs • Cap Screws • Nuts
In Alloys • Stainless • Carbon • Bronze

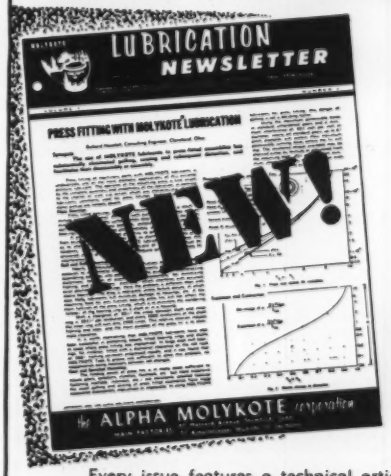
Your most exacting specifications take precision form in the hands of our expert craftsmen.
Bolts—Studs—Cap Screws—Nuts as specified to resist corrosion, extreme temperatures and tensile stresses are the product of more than 40 years continuous production of highest quality fasteners for a wide diversity of industries.
Send us your specifications for prompt estimate.

A SUBSIDIARY OF
BARIUM
STEEL CORPORATION

ERIE BOLT & NUT CO.
Erie, Pennsylvania
Representatives in Principal Cities

Circle 689 on page 19

A TECHNICAL NEWSLETTER ON LUBRICATION WITH MOLYKOTE . . .



IF YOU HAVEN'T RECEIVED YOUR COPY SEND FOR IT RIGHT AWAY!

Every issue features a technical article on the use of MOLYKOTE Lubricants in industry ● "How-to" stories on tough lubrication applications ● Filled with engineering data which applies to all industries ● Being published regularly.

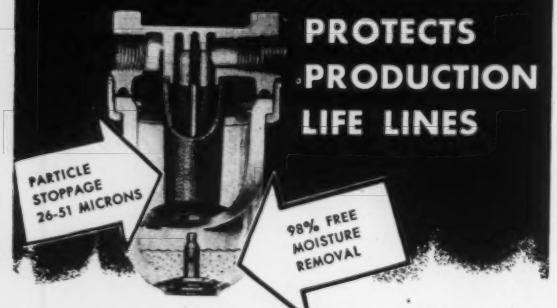
THE ALPHA MOLYKOTE CORP.

Main Factories: 65 Harvard Avenue, Stamford, Conn.
71 Arnulfstrasse, Munich 19, Germany

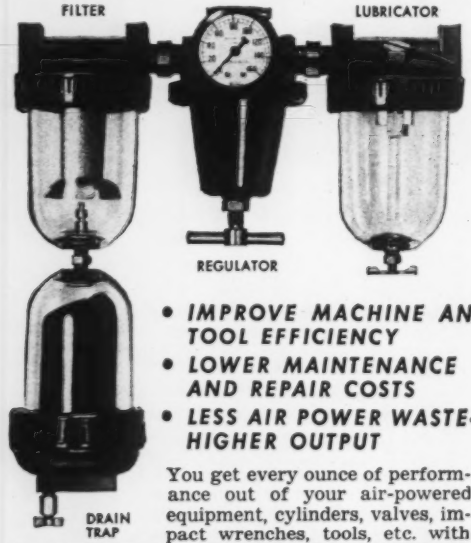
Circle 688 on page 19

Arrow AIR LINE FILTER

PROTECTS PRODUCTION LIFE LINES



Arrow Autopneumatic Controls Prevent Work Stoppage—Save Repairs



- *IMPROVE MACHINE AND TOOL EFFICIENCY*
- *LOWER MAINTENANCE AND REPAIR COSTS*
- *LESS AIR POWER WASTE—HIGHER OUTPUT*

You get every ounce of performance out of your air-powered equipment, cylinders, valves, impact wrenches, tools, etc. with the ARROW AUTOPNEUMATIC CONTROL ASSEMBLY. The compressed air is properly cleaned. The Regulator Valve controls pressure without waste of air and the ARROW Lubricator supplies the correct amount of fine oil mist in the air stream to properly lubricate appliances or tools in operation. The Automatic Trap discharges accumulated water to give perfectly *conditioned and controlled compressed air* for uninterrupted production schedules.

Tool down-time, operator lost time, parts replacements and expensive repairs are practically eliminated.

All the Facts Are Yours for the Asking

Let ARROW field consultants point the way to better production economy at no cost to you. ARROW will be happy to send you their engineering catalog and make recommendations.

Your inquiries invited.

ARROW TOOLS, INC.

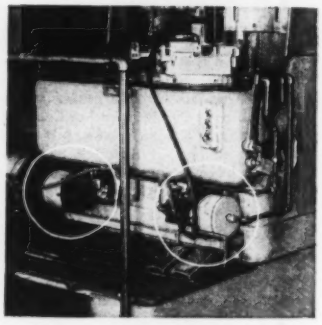
1918 S. KOSTNER AVE. • CHICAGO 23, ILL.

Circle 690 on page 19

Let Wagner solve YOUR ACTUATION PROBLEM

Wagner Electric Corporation offers a wide variety of air and hydraulic actuators and controls.

For specific applications, Wagner can furnish engineered kits with actuators, controls, tubing, fittings —everything required for complete installation. Your nearby Wagner field engineer will get you detailed specifications on a system for your particular application. Call him today.



Shown above is a broaching machine with swivel type clamping fixtures, utilizing the Wagner power cluster which converts air pressure to hydraulic pressure that is delivered to actuating cylinders on each of the clamping fixtures.

Wagner Electric Corporation

6404 PLYMOUTH AVE., ST. LOUIS 14, MO. 156-2A

Circle 691 on page 19

VALLEY BOLT

A Dependable Source for Precision Fasteners.

VALLEY BOLT

gives on-time deliveries and guaranteed quality.

VALLEY BOLT

offers standard or special fasteners in all super alloys.

VALLEY BOLT

provides experience, facilities and engineering assistance for your fastener problems.

VALLEY BOLT CORPORATION

6872 FARMDALE AVE., N. HOLLYWOOD, CALIF.

2010 MEMORIAL DR., TULSA, OKLA.

Circle 692 on page 19

HOBBS

COTTER PINS

LOXIT
Extended Prong

HOBLOK
Hammer-Lock Type

Locks itself when hit with hammer!
No bending of prongs required!

Choose the type that's best for *your* production job! Both are available in steel, brass, stainless steel, and monel.

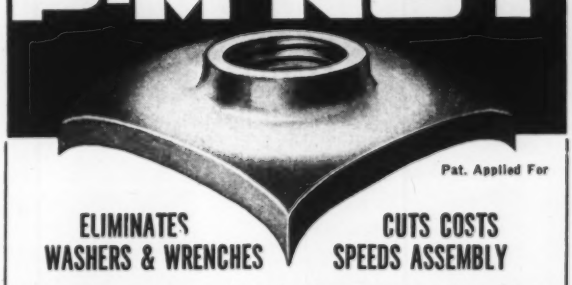
HOBBS "TANGLE-PROOF" LOCKWASHERS are available in high carbon steel, stainless steels, silicon and phosphor bronze, and all types of platings.

Write now for Hobbs lock washer and cotter pin price lists!

HOBBS MANUFACTURING CO.
Fastener Division
47H SALISBURY ST., WORCESTER 5, MASS.
EST. 1883

Circle 693 on page 19

SELF-GRIPPING • SELF-LOCKING
P-M NUT



Pat. Applied For

ELIMINATES WASHERS & WRENCHES
CUTS COSTS SPEEDS ASSEMBLY

High-quality, low-cost nut is made of spring-tempered high carbon steel. Has cut threads and a flange with turned-down corners which bite into material to which applied. Spring flange is deflected during tightening for vibration-proof assembly. Used by leading manufacturers. Available in sizes 6-32 thru 10-32. Other sizes in process.

P-M "ROLL FREE"
DRAWN STEEL STUD

Pat. Applied For

Low-cost "Roll Free" studs effect unusual savings over solid studs for most roller mounting. Smooth surface reduces friction for easier rolling, longer life. Standard sizes or to your specifications. For additional savings, ask us about pre-assembled studs and rollers.

Write for FREE Literature and Samples

P-M Division
THE WATERBURY PRESSED METAL CO.
PLAIN STAMPINGS ★ PROGRESSIVE STAMPINGS ★ EYELETS
DRAWN SHELLS ★ SECONDARY OPERATIONS ★ ASSEMBLING
300 CHASE AVE. • WATERBURY 14, CONN.

Circle 694 on page 19

ELCO SCREWS
. . . Ask a man who has used them

Elco Screws are Good Screws

REMEMBER ELCO

THREAD-CUTTING SCREWS

Many modern assemblies, particularly in plastics and soft metals, make use of these vital fasteners. ELCO is equipped to produce all standard types and sizes (or specials if desired) in any quantities, at economical prices, and usually for prompt delivery. Send prints for quotation. *Write for free package of samples.*

WOOD SCREWS
MACHINE SCREWS
MACHINE SCREW NUTS
TAPPING SCREWS
THREAD-CUTTING SCREWS
PHILLIPS AND SEMS SCREWS
PIPE PLUGS
STOVE BOLTS
CAP SCREWS
LAG SCREWS
DRIVE SCREWS
SPECIAL SCREWS
COLD HEADED PRODUCTS

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WE ALSO SPECIALIZE IN MAKING ANY OF OUR PRODUCTS OF THE FOLLOWING MATERIALS

Stainless Steel
Bronze
Brass
Copper
Silicon Bronze
Ambrac
Monel
Aluminum
Special Analysis

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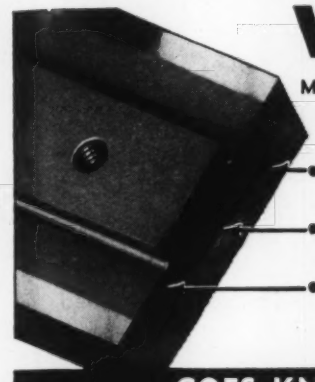

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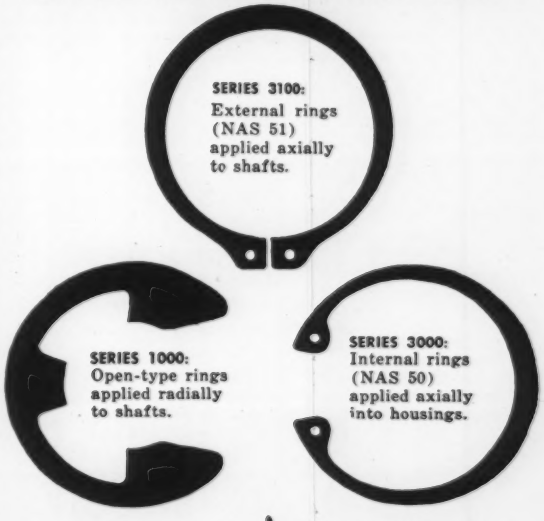

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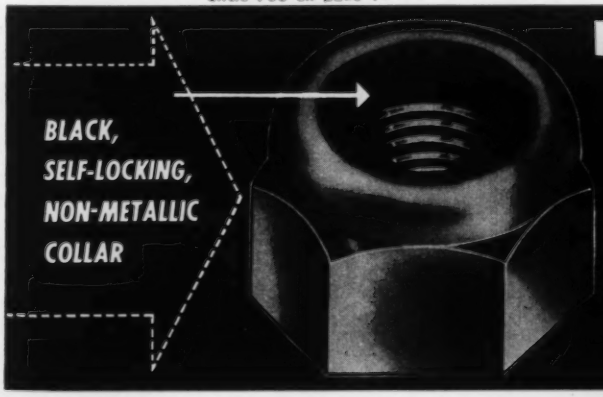

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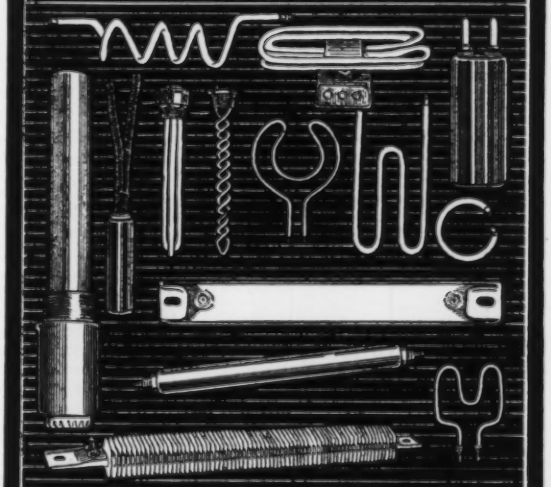

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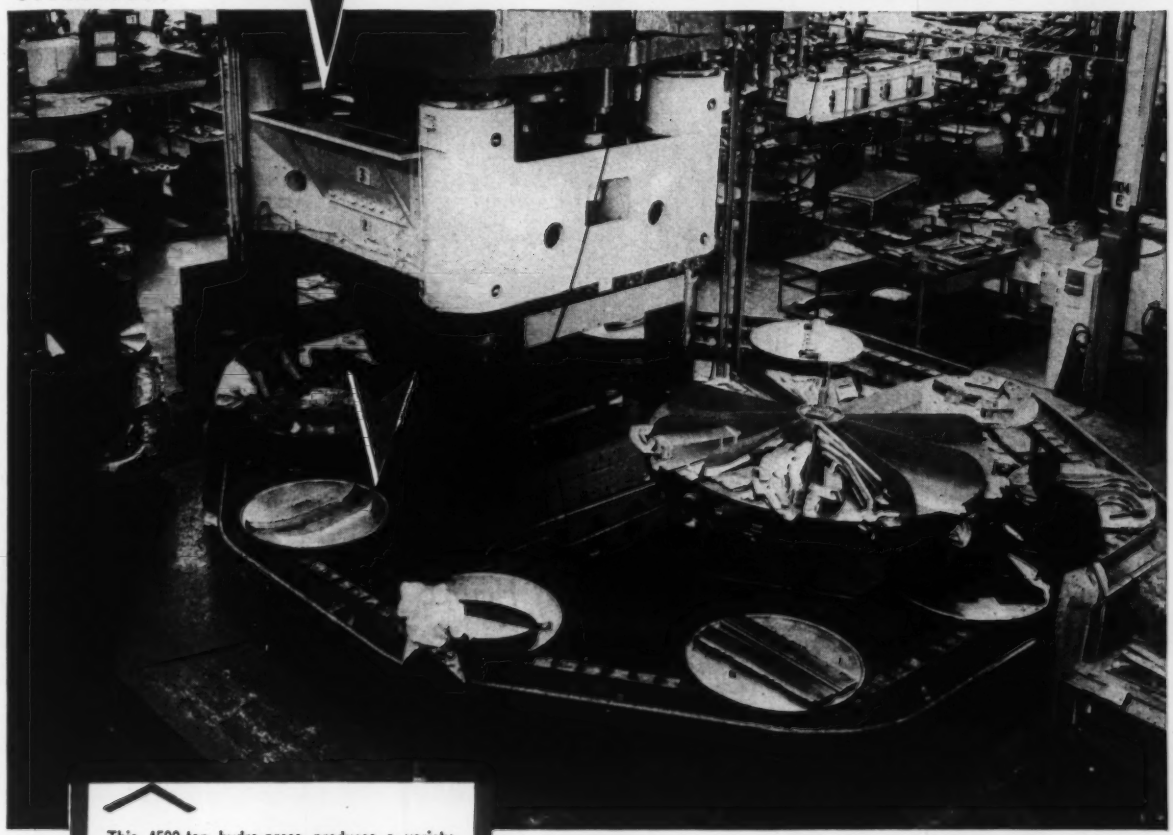

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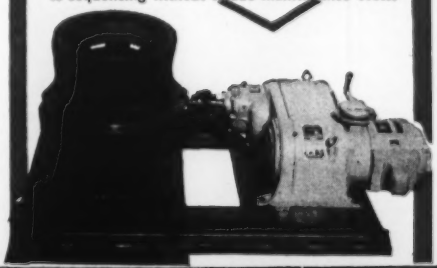

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This is another example of the outstanding performance of FAWICK Products in many industries. For more information on how FAWICK can improve the performance of your machines, call or write your nearest FAWICK Representative or the Home Office today.

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FAWICK CORPORATION
9919 CLINTON ROAD • CLEVELAND 11, OHIO
In Canada: Fawick Canada, Ltd., Toronto, Montreal

FAWICK Airflex
INDUSTRIAL CLUTCHES AND BRAKES

REVERE COPPER EXTRUSION shown attached to skirtboard before full assembly, which you can see below in exploded view. A matching bar, similar to the one shown is part of the "packaged" HANCO unit and is fastened to the opposite side of the screen. Units, in turn, are installed on the various types of Vibrating Screens made by HEWITT-ROBINS INC., Passaic, N. J., and are known as the HEWITT-ROBINS HANNON Electric Screen Heaters.

CLOSE-UP showing end of the Revere Copper Extrusion.

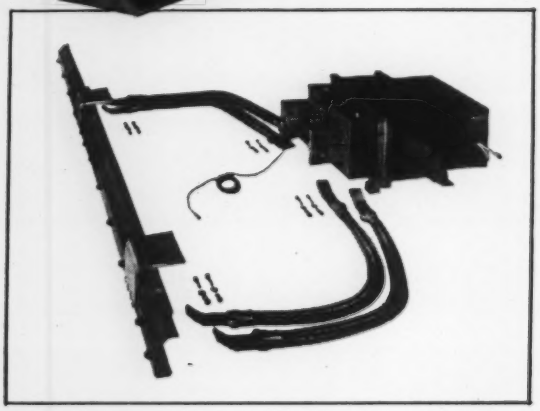
Revere Copper Extruded Shape

in Hanco Electric Screen Heater

out-performs

former copper casting

on 4 counts



"Customers of F. R. Hannon & Sons are now assured of many years of maintenance-free performance plus improved products."

Says T. W. HANNON, *Vice-President, General Manager*
F. R. HANNON & SONS, Canton, Ohio

Mr. Hannon continued, "For a number of years we had experimented with many different types of materials which would be non-porous, free from any burrs or voids, capable of maintaining a straight leading edge and able to carry 1500 amperes at 5 volts. The Revere Copper Extrusion meets these requirements. And for the rugged use to which our machines are put it would be virtually impossible to maintain satisfactory operating results without the use of this extruded electrical conductor."

Perhaps there is a Revere Product that can help you give *your* customers a superior product, or help cut your production costs. You'll never know until you call the Revere Office nearest you and ask to have a T. A. (Technical Advisor) call. Why not make that call today?

Here's the Score!

COPPER EXTRUDED SHAPE	COPPER CASTING
1—12 foot mill lengths offer flexibility, eliminating both welds and scrap	1—60" casting required additional welded joints
2—Shape offers lack of porosity	2—Casting gave porosity problem
3—Shape straightness is superior to casting, giving better electrical contact	3—Bow in casting presented difficulty when fastening screen firmly to contact
4—Higher cost per foot, but cheaper over-all installation	4—Initial cost was lower, but additional welds and scrap resulted in higher final cost, and an inferior finished product

REVERE COPPER AND BRASS INCORPORATED
Founded by Paul Revere in 1801
230 Park Avenue, New York 17, N. Y.
Mills: Baltimore, Md.; Brooklyn, N. Y.; Chicago, Clinton and Joliet, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Newport, Ark.; Rome, N. Y.
Sales Offices in Principal Cities, Distributors Everywhere.

COPPER ★ BRASS ★ 18 01 ★ REVERE ★ ALUMINUM

Six of nine Cleveland Worm Gear Drives in use on the Anvil Lift Drive of this Mesta Gag Press are in view.

Gag press uses 9 CLEVELAND drives to straighten steel

BIG equipment . . . doing a big job. Smooth, powerful, dependable speed transmission is vital here—and this gag press, designed and built by Mesta Machine Company, has it . . . thanks to 9 Cleveland Worm Gear Drives.

Cleveland Worm Gearing—the dependable drive—affords exceptional advantages for practically any power job. Steel worm on bronze gear provides the best possible medium to transmit power with minimum friction and wear—reduces motor speed evenly, efficiently and quietly. Right angle drive makes a worm gear reducer compact and rugged, with few moving parts. And when it's a Cleveland, you get extra benefits from 44 years of experience concentrated on making worm gear drives.

Get the full Cleveland story on power transmission. Write for Catalog 400; ask for technical advice on any problem you may have. Then, you'll specify Cleveland Worm Gear Drives. The Cleveland Worm and Gear Company, 3287 East 80th Street, Cleveland 4, Ohio.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.

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